American Journal of Public Health Research, 2015, Vol. 3, No. 1, 1-7
Available online at http://pubs.sciepub.com/ajphr/3/1/1

DOI:10.12691/ajphr-3-1-1

Study of the Effects of Snack-Centered Dietary Education on First-Grade Elementary Students and Duration of These Effects

Toshiyuki Kohri*, Naoko Kaba

Department of Food and Nutrition, Faculty of Agriculture, Kinki University, Nara, Japan
*Corresponding author: tkohri@nara.kindai.ac.jp

Received December 12, 2014; Revised January 04, 2015; Accepted January 09, 2015

Abstract Irregular diets and nutrient imbalances that result from a lack of interest in food have become more common among not only adults but also children. Snacks are a category of food that most children like and can select for themselves. This study validated the effects of snack-centered dietary education for children on the ability of snack selection and duration of these effects. Twenty-three types of snacks, including drinks, were lined up on a table and presented to 103 Japanese first grade elementary students (intervention group) in a snack selection test in which children were allowed to freely select the snacks they would eat in one day. The ability of children to select the proper quality and quantity of snacks was evaluated on the basis of the energy and nutrient content of the selected snacks. Subsequently, snack-centered dietary education intervention lessons were provided to the children, and the same test conducted at baseline was immediately reconducted after the intervention and seven months after the end of the intervention. The control group comprised 118 children who were in the first grade during the subsequent school year. In the intervention group, the snacks selected in the baseline test had excessive energy content; post-intervention, the energy content approached a more appropriate level and the nutrient density of vitamins, iron, and dietary fiber increased. Moreover, these improvements were observed even seven months after the intervention ended. However, in the control group, there were no significant changes. These findings suggested that snack-centered dietary education for first grade elementary students contributed to improving the quality and quantity of snack selection, and these effects persisted for more than half a year.

Keywords: *snack, dietary education, diet, food, nutrition, children, intervention*

Cite This Article: Toshiyuki Kohri, and Naoko Kaba, "Study of the Effects of Snack-Centered Dietary Education on First-Grade Elementary Students and Duration of These Effects." *American Journal of Public Health Research*, vol. 3, no. 1 (2015): 1-7. doi: 10.12691/ajphr-3-1-1.

1. Introduction

Because excessive amounts of food have been available since a long time in developed countries, irregular diets and nutrient imbalances that result from a lack of interest in food have become highly prevalent. As a result, obesity [1] and an excessive desire to be slim [2,3], which are risk factors for lifestyle-related diseases have become more common among not only adults but also children in recent years. Moreover, dietary habits strongly contribute to these problems. Dietary habits and preferences during childhood majorly contribute to the mental and physical growth as well as personality development and are said to affect a person throughout their lifetime [4,5]. Furthermore, because it is difficult to change dietary habits in adulthood, the importance of forming good dietary habits during childhood has been noted [6]. Therefore, in Japan, the Basic Act on Food Education was passed in 2005, and many elementary schools began providing dietary education at that time. However, even if young children receive dietary education that is focused on foods for meals, they often eat what is given to them at home or school for their daily meals and have few opportunities to select foods for themselves. Therefore, it is difficult for them to apply what they have learned in dietary education to real life. However, children may have a certain amount of opportunity to select snacks for themselves [7]. Furthermore, as young children are highly interested in snacks [8], dietary education that is designed around snacks can be effective in raising the interest of children in the lessons.

For young children, snacks serve to supplement the energy and nutrients that are not sufficiently provided by the three daily meals, and they serve emotional roles, such as those in mood shifts [9]. However, many problems, such as obesity, have arisen from the excessive consumption of junk food or soft drinks by elementary-aged children [10].

These kinds of snacks have a large impact on the health of the children. Therefore, the objective of this study was to conduct a dietary education intervention that was designed around snacks for children and provide them the ability to consider and select the appropriate quantity and quality of snacks to eat in one day.

Previous studies that assessed the effects of dietary education on children have used several questionnaires or recalls of dietary intake [11,12]. However, these abilities of children limit the accuracy of food surveys [13,14]. In addition, the dietary intake of young children has been previously evaluated with answers provided by parents or guardians, issues with these methods have also been reported [15]. This is because parents do not have a sufficient grasp of the types and quantities of food that their children consume [16].

Therefore, the method used in this study to evaluate the effects of snack-centered dietary education for children did not rely on the memory of children or answers of parents. Another objective of this study was to study the duration of the effects of dietary education.

2. Materials and Methods

2.1. Subjects

The study subjects were first grade students from a private elementary school in Nara Prefecture, western Japan. Because of educational considerations, the elementary school students were not divided into the intervention and control groups during the same school year; rather, 103 children in the first grade during the 2009 school year (55 boys, 48 girls) were assigned to the intervention group, and 118 children in the first grade during the 2010 school year (64 boys, 54 girls) were assigned to the control group. A follow-up study was conducted when the children of the intervention group were in the second grade. A complete data set of study items was ultimately collected for 98 children (51 boys, 47 girls) in the intervention group and 106 children (58 boys, 48 girls) in the control group. Data from these children were used in the analysis. This study was conducted with the approval of the Life Ethics Committee of Kinki University Faculty of Agriculture. Consent was obtained from all children and guardians before commencing the study.

2.2. Study Design

The study design was as follows. A baseline test was conducted with children in the first grade during the 2009 school year (intervention group) in late June, and dietary education intervention lessons were conducted between July and November (45 min × 3 lessons). Then, in early December, a post-intervention test with the same items as the baseline test was conducted. One year later during the same months, Baseline 1 and Baseline 2 tests containing the same items as the intervention group, but without the dietary education lessons, were conducted with children in the first grade during the 2010 school year (control group). In addition, a seven-month follow-up test with the same items as the baseline test was conducted in the intervention group in late June when they were in the second grade during the 2010 school year.

2.3. Dietary Education Goals and Overview of the Intervention Lessons

The two goals of the dietary education intervention in the intervention group were as follows:

1) To increase the percentage of children who select daily snacks containing 200 kcal of energy or less because a new food guide in Japan [17] recommends that the daily energy intake from snacks should be approximately 200 kcal.

2) To increase the frequency with which children select snacks with a low percentage of energy from fat and a high nutrient density of vitamins, fiber, and calcium.

To achieve these two goals, three dietary education intervention lessons were provided. An overview of these lessons is as follows. In Lesson 1, children were taught that snacks can be classified into the following groups on the basis of their main components: (1) snacks, such as candy that taste sweet and have a lot of sugar, (2) snacks, such as potato chips that feel greasy and have a lot of fat, and (3) snacks, such as roasted sweet potatoes and milk that have a lot of vitamins, dietary fiber, and calcium and are good for the body. The children were then instructed to sort actual snack items into these groups. In Lesson 2, to help the children visualize the appropriate amount of snacks to eat in one day (≤200 kcal), they were told that the appropriate energy content was approximately the same as that of a bowl of rice that they would normally eat (approximately 200 kcal). They were also asked how much rice would have the same energy content of typical snacks in a quiz format. In addition, they were instructed to practice combining actual snacks for one day so that the energy content would be less than or equal to that of a bowl of rice. The theme of Lesson 3 was that the children would teach their family the correct way of selecting snacks so that their family could be healthy together. They summarized what they learned at school about selecting snacks in a letter, took the letter home with them, gave it to their parents, and explained it to them. The purpose of this exercise was to have children get their family to understand the facts about snacks and increase the awareness of the child by having them personally explain how to select snacks to their family.

2.4. Snack Selection Test with the Children

A snack selection test was conducted with the children with 23 types (17 foods and six drinks) of real snacks. The types of snacks used in the test were as follows: (1) sugary snacks (hard candy, fizzing candy, orange jelly without fruit juice, caramels, cola, sweetened drinks, and sports drinks); (2) fatty snacks (potato chips, chocolate, cookies, and ice cream); and (3) snacks with a lot of vitamins, dietary fiber, or calcium [pancakes, roasted sweet potatoes, dorayaki (sponge cake with red bean jam sandwiched in between), custard, yogurt, fruit, 100% fruit juice, milk, and green tea]. Further, snacks in categories (1) and (2) were assigned to a low nutritional value food group, whereas snacks in category (3) were assigned to a high nutritional value food group. Typical portion sizes of the snacks were used. The serving sizes, energy content, and main nutrient compositions of these foods are listed in Table 1. The energy and nutrient composition of the snacks were calculated using the ingredient list of processed foods in the market (The 8th Edition) or the Standard Tables of Food Composition in Japan (Fifth revised and enlarged edition) [18]. These snacks were placed on the top of a short table in a standardized position. The test administrators gave each child a basket

for the snacks and told them to "Please take a look at all the snacks on the table, then pick up as many snacks as you would want to eat in one day and put them in the basket." Once they had finished selecting the snacks, they returned the basket to the test administrator. The test administrator then recorded the types and number of snacks in the basket and returned the snacks to their original position on the table. Two servings or more of each type of snack were placed on the table so that the children could select multiple items of the same snack. The tests were conducted in the morning, and the children were tested one at a time to avoid any influence from the other children. This method did not rely on the memory of the children or a survey of their parents, and it was used to directly evaluate the ability of the children to select snacks.

Table 1. Names, Serving Sizes, and Main Nutritional Components of the Snacks Used in the Snack Selection Test

Snacks (including beverages)	Gram per serving	Energy (kcal)	Protein (g)	Fat (% energy)	Calcium (mg)	Iron (mg)	Vitamin A (μgRE)	Vitamin B_1 (mg)	Vitamin B_2 (mg)	Vitamin C (mg)	Dietary fiber (g)	Salt (g)
Candy	7.2	28	0.0	0.0	0.1	0.0	0.0	0.00	0.00	0.0	0.0	0.0
Fizzing candy	29	111	0.0	0.0	0.3	0.0	0.0	0.00	0.00	0.3	0.0	0.0
No fruit juice jelly	100	70	2.3	0.0	3.0	0.1	1.0	0.02	0.00	7.0	0.1	0.0
Caramel	4.8	21	0.2	24.3	9.1	0.0	5.3	0.00	0.01	0.0	0.0	0.0
Potato chips	28	155	1.3	57.2	4.8	0.5	0.0	0.07	0.02	4.2	1.2	0.3
Chocolate	5.5	31	0.4	54.9	13.2	0.1	3.6	0.01	0.02	0.0	0.2	0.0
Cookie	17	89	1.0	47.6	3.4	0.1	25.5	0.01	0.01	0.0	0.2	0.1
Ice cream	120	255	3.7	54.6	114.0	0.1	12.0	0.04	0.18	0.0	0.0	0.2
Pancake	70	183	5.3	19.0	77.0	0.4	29.4	0.06	0.13	0.0	0.8	0.5
Roast sweet potato	70	114	1.0	1.1	23.8	0.5	0.7	0.08	0.04	16.1	2.5	0.0
Dorayaki*	90	256	5.6	8.2	19.8	0.8	25.2	0.07	0.09	0.0	3.2	0.3
Custard	75	95	4.1	35.7	60.8	0.5	58.5	0.04	0.20	0.0	0.0	0.2
Yogurt	80	50	2.9	43.5	96.0	0.0	26.4	0.03	0.11	0.8	0.0	0.1
Orange	50	23	0.5	2.0	12.0	0.1	5.5	0.04	0.02	30.0	0.5	0.0
Kiwi	65	34	0.7	1.7	21.5	0.2	3.9	0.01	0.01	44.9	1.6	0.0
Banana	50	43	0.6	2.1	3.0	0.2	2.5	0.03	0.02	8.0	0.6	0.0
Apple	75	41	0.2	1.7	2.3	0.0	1.5	0.02	0.01	3.0	1.1	0.0
Cola	250	115	0.3	0.0	5.0	0.0	0.0	0.00	0.00	0.0	0.0	0.0
Sweetened drink	300	132	0.8	0.0	0.0	0.0	0.0	0.00	0.00	0.0	0.0	0.0
Sports drink	300	54	0.0	0.0	3.0	0.0	0.0	0.00	0.00	9.0	0.0	0.3
100% Orange juice	200	84	1.6	0.0	18.0	0.2	6.0	0.14	0.02	44.0	0.6	0.0
Milk	200	134	6.6	51.0	220.0	0.0	76.0	0.08	0.30	2.0	0.0	0.2
Green tea	250	13	3.3	0.0	10.0	0.5	0.0	0.05	0.28	47.5	0.0	0.0

*Dorayaki; sponge cake with red bean jam sandwiched in between

2.5. Reference Values for the Energy and Nutrient Content of the Snacks

Table 2. Reference values of selected snacks for the energy and nutrients per 100 kcal in the snack selection test*

	Over	Proper	Deficiency
Energy (kcal)	>200	≤200	
Protein (g/100 kcal)		≥2.0	<2.0
Fat (percent energy)	>30	≤30	
Vitamin A (μgRE/100 kcal)		≥28.3	<28.3
Vitamin B_1 (mg/100 kcal)		≥0.05	<0.05
Vitamin B_2 (mg/100 kcal)		≥0.05	<0.05
Vitamin C (mg/100 kcal)		≥3.7	<3.7
Calcium (mg/100 kcal)		≥38.3	<38.3
Iron (mg/100 kcal)		≥0.4	<0.4
Dietary fiber (g/100 kcal)		≥0.8	<0.8
Salt (g/100 kcal)	≥0.4	<0.4	

*Subjects selected as many snacks as they would want to eat in one day in the snack selection test. A new food guide in Japan recommends that the daily energy intake from snacks should be approximately ≤200 kcal. In accordance with the Dietary Reference Intakes for Japanese that was issued in 2010, the appropriate percentage of energy from fat was considered to be ≤30%, and for other nutrients, the appropriate ranges of nutrient density per 100 kcal were calculated using the RDA or AI.

Table 2 shows reference values for the energy and nutrient content of the snacks. The appropriate energy content for the snacks in the snack selection test was considered to be ≤200 kcal. Because the children selected the snacks by sight, a standard of <260 kcal was also included in the evaluation to account for error. In addition, in accordance with the Dietary Reference Intakes for Japanese that was issued in 2010, the appropriate percentage of energy from fat (%) was considered to be ≤30%, and for other nutrients, the reference values (appropriate ranges) of nutrient density per 100 kcal were calculated using the average recommended dietary allowances (RDA) or adequate intakes (AI) for boys and girls with the following equation (1):

$$\text{Reference values of nutrient density} = \frac{(\text{RDA or AI})}{(\text{Estimated energy requirement})} \times 100 \text{ kcal} \quad (1)$$

2.6. Statistical Analysis

All statistical analyses were performed using the SPSS statistical software package version 20.0 and p values of <0.05 were considered statistically significant. The results were pooled for the boys and girls because there were no gender differences. The changes in the average energy and nutrient content of the snacks selected by the intervention or control groups were assessed with a within-participant analysis of variance (ANOVA). Changes in the percentages of children in the intervention or control groups who selected snacks with energy and nutrient contents within appropriate ranges were assessed using the Cochran's Q test. The baseline averages were compared between the intervention and control groups using unpaired *t*-tests, and the baseline percentages were compared between the groups using chi-squared tests.

3. Results

The average (absolute) amounts of energy and nutrients in the day's worth of snacks that were selected by the children are shown in Table 3.

Table 3. Energy and Nutrients (Absolute Amount) in the Day's Worth of Snacks Selected by the Children

Absolute amount per day	Intervention group(n = 98)									Control group (n = 106)					
	Baseline			End of intervention			7-month follow-up			Baseline 1			Baseline 2		
Energy (kcal)	511.9	±	417.9	362.4	±	342.3***	388.9	±	429.1#	632.9	±	416.1x	584.5	±	478.2
Protein (g)	9.3	±	7.7	8.6	±	7.2	7.8	±	7.0	11.4	±	7.9	10.7	±	9.4
Fat (% energy)	30.0	±	14.6	21.9	±	15.0***	26.2	±	16.3	29.8	±	12.5	28.4	±	14.6
Vitamin A (μgRE)	74.5	±	62.4	63.6	±	58.3	61.0	±	60.5	88.1	±	67.2	79.7	±	74.1
Vitamin B_1(mg)	0.15	±	0.14	0.15	±	0.12	0.14	±	0.13	0.21	±	0.16	0.19	±	0.16
Vitamin B_2 (mg)	0.31	±	0.28	0.33	±	0.27	0.30	±	0.26	0.40	±	0.28x	0.36	±	0.32
Vitamin C (mg)	24.1	±	36.4	45.4	±	43.5***	36.0	±	36.3#	39.6	±	45.1xx	37.3	±	43.8
Calcium (mg)	174.4	±	160.6	152.9	±	145.1	153.6	±	138.4	212.1	±	157.7	190.6	±	186.0
Iron (mg)	0.82	±	0.80	0.88	±	0.77	0.73	±	0.82	1.20	±	0.84xx	1.08	±	0.88
Dietary fiber (g)	2.0	±	2.5	2.4	±	2.3	1.8	±	2.5	3.0	±	2.6xx	2.6	±	2.6
Salt (g)	0.51	±	0.46	0.42	±	0.42	0.40	±	0.44	0.64	±	0.49	0.58	±	0.54

Values are means ± SDs.
*P < 0.05, **P < 0.01, ***P < 0.001: Baseline vs. End of intervention (Within-participant ANOVA)
#P < 0.05: Baseline vs. 7-month follow-up (Within-participant ANOVA)
Baseline 1 vs. Baseline 2 (Within-participant ANOVA) was not a significant difference.
xP < 0.05, xxP < 0.01: Baseline at intervention group vs. Baseline1 at control group (Unpaired t test)

Table 4. Average Number of Each Type of Snack Selected per Child during the Snack Selection Test

	Foods	Intervention group (n = 98)						Control group (n = 106)			
		Baseline		End of intervention		7-month follow-up		Baseline 1		Baseline 2	
		Each[a]	Group sum[b]	Each[a]	Group sum[b]	Each[a]	Group sum[b]	Each[a]	Group sum[b]	Each[a]	Group sum[b]
Low nutritional foods group	Candy	0.16		0.11		0.11		0.21		0.25	
	Fizzing candy	0.30		0.11		0.12		0.32		0.32	
	No fruit juice jelly	0.15		0.24		0.12		0.24		0.28	
	Caramel	0.45		0.16		0.14		0.69		0.75	
	Cola	0.15		0.05		0.13		0.17		0.20	
	Sweetened drink	0.36	3.36 ± 3.28	0.09	1.91 ± 2.16***	0.16	1.86 ± 1.88###	0.38	4.34 ± 3.45x	0.26	4.29 ± 3.88
	Sports drink	0.18		0.26		0.16		0.18		0.18	
	Potato chips	0.37		0.19		0.21		0.53		0.43	
	Chocolate	0.46		0.32		0.23		0.85		0.85	
	Cookie	0.39		0.27		0.23		0.41		0.40	
	Ice cream	0.39		0.10		0.21		0.38		0.37	
High nutritional foods group	Pancake	0.13		0.15		0.09		0.23		0.21	
	Roast sweet potato	0.16		0.24		0.11		0.23		0.24	
	Dorayaki	0.10		0.15		0.09		0.15		0.12	
	Custard	0.43		0.24		0.22		0.43		0.39	
	Yogurt	0.15		0.27		0.15		0.21		0.10	
	Orange	0.10	1.88 ± 2.15	0.23	2.49 ± 1.86*	0.23	1.90 ± 1.43	0.19	2.86 ± 2.56xx	0.25	2.34 ± 2.35Y
	Kiwi fruit	0.12		0.22		0.12		0.17		0.12	
	Banana	0.11		0.19		0.22		0.36		0.21	
	Apple	0.16		0.15		0.08		0.28		0.17	
	Orange juice	0.13		0.06		0.13		0.20		0.17	
	Milk	0.24		0.27		0.28		0.28		0.26	
	Green tea	0.02		0.30		0.15		0.13		0.10	

The snacks were divided into low and high nutritional foods groups.
[a]Values for "Each" are the average number of each type of snack that was selected per child.
[b]Values for "Group sum" are means ± SDs of the total number of snacks that were selected per child within each group.
*P < 0.05, ***P < 0.001; Baseline vs. End of intervention (Within-participant ANOVA)
###P < 0.001; Baseline vs. 7-month follow-up (Within-participant ANOVA)
YP < 0.05; Baseline 1 vs. Baseline 2 (Within-participant ANOVA)
xP < 0.05, xxP < 0.01; Baseline at intervention group vs. Baseline1 at control group (Unpaired t test)

In the intervention group, the energy content was significantly lower immediately after the intervention (early December) relative to the baseline (late June) ($p < 0.001$), and it remained significantly low seven months after the intervention ended ($p < 0.05$). Although the energy contents in the snacks were lower immediately after the intervention relative to the baseline, vitamin C was significantly higher ($p < 0.001$), and it remained significantly high seven months after the intervention ended ($p < 0.05$). Furthermore, fat was significantly lower immediately after the intervention relative to the baseline ($p < 0.001$), and it remained low seven months after the intervention ended, although not significantly. No significant differences compared with baseline were observed for any other nutrient. In the control group, there were no significant changes in the energy or nutrient contents of the snacks between Baseline 1 (late June) and Baseline 2 (early December). When the intervention and control groups were compared at baseline, energy, vitamin B_2, vitamin C, iron, and dietary fiber were significantly higher in the control group.

The average number of each type of snack that was selected perchild is shown in Table 4. The snacks were divided into low and high nutritional value groups, and the total number of snacks that were selected was calculated within each group. The number of snacks with low

nutritional value was calculated by adding the number of items selected among the candy, fizzing candy, jelly without fruit juice, caramel, cola, sweetened drinks, sports drinks, potato chips, chocolate, cookies, and ice cream; the number of snacks with high nutritional value was calculated by adding the number of items selected among pancakes, roasted sweet potatoes, dorayaki, custard, yogurt, oranges, kiwi fruit, bananas, apples, orange juice, milk, and green tea. In the intervention group, the number of selected snacks in the low nutritional value group was significantly lower, and the number of selected snacks in the high nutritional value group was significantly higher relative to the baseline. In contrast, in the control group, there was no difference in the number of selected snacks in the low nutritional value group between Baseline 1 and Baseline 2, and the number of selected snacks in the high nutritional value group was significantly lower at Baseline 2. In addition, when the intervention group was tested again seven months after the intervention ended, the number of selected snacks in the low nutritional value group remained significantly lower than the baseline number, but there was no difference in the number of selected snacks in the high nutritional value group. In the baseline comparison between the intervention and control groups, the numbers of selected snacks in the low and high nutritional value groups were both significantly higher in the control group.

Table 5. Nutrients per 100 kcal in the Day's Worth of Snacks Selected by the Children

Nutrient density per 100 kcal	Intervention group(n = 98)									Control group (n = 106)					
	Baseline			End of intervention			7-month follow-up			Baseline 1			Baseline 2		
Protein (g)	1.9	±	1.1	2.5	±	1.6***	2.4	±	1.6$^{\#\#}$	2.0	±	1.0	1.9	±	1.2
Vitamin A (μgRE)	17.1	±	15.0	18.5	±	14.5	18.4	±	16.2	15.3	±	10.5	14.3	±	11.4
Vitamin B_1(mg)	0.03	±	0.02	0.05	±	0.03***	0.04	±	0.03$^{\#\#\#}$	0.04	±	0.02^{xx}	0.04	±	0.03
Vitamin B_2 (mg)	0.07	±	0.05	0.11	±	0.10***	0.10	±	0.10$^{\#\#}$	0.08	±	0.07	0.07	±	0.07
Vitamin C (mg)	4.2	±	5.8	20.1	±	28.6***	19.3	±	33.8$^{\#\#\#}$	8.5	±	13.3^{xx}	9.2	±	15.0
Calcium (mg)	36.9	±	34.8	46.5	±	44.4	49.2	±	44.0	36.7	±	28.4	32.9	±	26.5
Iron (mg)	0.15	±	0.11	0.26	±	0.21***	0.22	±	0.22$^{\#}$	0.21	±	0.12^{xx}	0.21	±	0.14
Dietary fiber (g)	0.34	±	0.37	0.73	±	0.63***	0.59	±	0.79$^{\#}$	0.49	±	0.37^{xx}	0.47	±	0.38
Salt (g)	0.10	±	0.06	0.11	±	0.07	0.09	±	0.07	0.10	±	0.05	0.09	±	0.05

Values are means ± SDs.
*P < 0.05, **P < 0.01, ***P < 0.001; Baseline vs. End of intervention (Within-participant ANOVA)
$^{\#}$P < 0.05, $^{\#\#}$P < 0.01, $^{\#\#\#}$P < 0.001; Baseline vs. 7-month follow-up (Within-participant ANOVA)
Baseline 1 vs. Baseline 2 (Within-participant ANOVA) was not a significant difference.
^{x}P < 0.05, ^{xx}P < 0.01; Baseline at intervention group vs. Baseline1 at control group (Unpaired t test)

The average amounts of nutrients per 100 kcal in the day's worth of snacks selected by the children are shown in Table 5. In the intervention group, the amounts of protein, vitamins B_1/B_2/C, iron, and dietary fiber per 100 kcal were significantly higher immediately after the intervention relative to the baseline, and they were still significantly high seven months after the intervention. No significant differences from baseline were observed for any of the other nutrients. In contrast, in the control group, there was no significant difference between Baseline 1 and Baseline 2. In the baseline comparison between the intervention and control groups, the intakes of vitamin B_1, vitamin C, iron, and dietary fiber per 100 kcal were significantly higher in the control group.

The percentages of children who selected a day's worth of snacks that had energy and nutrient contents per 100 kcal within appropriate ranges are shown in Table 6.

Table 6. Percent of Children within an Appropriate Range of Energy and Nutrient per 100 kcal

(%)	Intervention group(n = 98)			Control group (n = 106)	
	Baseline	End of intervention	7-month follow-up	Baseline 1	Baseline 2
Energy (≤ 200 kcal)	21.4	33.7*	32.7$^{\#}$	13.2	17.9
Energy (≤ 260 kcal)	27.6	49.0***	41.8$^{\#\#}$	19.8	20.8
Protein	27.6	51.0***	48.0$^{\#\#\#}$	34.9	30.2
Fat	40.8	69.4***	53.1$^{\#\#\#}$	51.9	52.8
Vitamin A	19.4	22.4	22.4	10.4	11.3
Vitamin B_1	12.2	34.7***	34.7$^{\#\#\#}$	19.8	18.9
Vitamin B_2	51.0	64.3*	63.3$^{\#}$	65.1^{x}	51.9^{a}
Vitamin C	36.7	69.4***	60.2$^{\#\#\#}$	49.1	51.9
Calcium	32.7	45.9*	45.9$^{\#}$	34.0	27.4
Iron	4.1	21.4***	15.3$^{\#\#}$	4.7	6.6
Dietary fiber	8.2	35.7***	21.4$^{\#}$	15.1	17.0
Salt	100.0	100.0	100.0	100.0	100.0

For energy, the percentage of children who selected a day's worth of snacks with values of ≤200 kcal or ≤260 kcal.
For nutrients, the appropriate rangesof nutrient density per 100 kcal were calculated using the RDA or AI,
and the percentage indicates the percentage of children whose choices fit within the appropriate ranges.
*P < 0.05, ***P < 0.001; Baseline vs. End of intervention (Cochran's Q test)
$^{\#}$P < 0.05, $^{\#\#}$P < 0.01, $^{\#\#\#}$P < 0.001; Baseline vs. 7-month follow-up (Cochran's Q test)
^{a}P < 0.05; Baseline 1 vs. Baseline 2 (Cochran's Q test)
^{x}P < 0.05; Baseline at intervention group vs. Baseline1 at control group (Chi square test)

In the intervention group, the percentage of children whose choices fit within the appropriate energy limit (≤200 kcal) significantly increased immediately after the intervention relative to the baseline, and it remained significantly high seven months after the intervention. In addition, a similar increase was observed when the appropriate limit was raised to ≤260 kcal. The percentages of children whose choices fit within the appropriate ranges also significantly increased immediately after the intervention relative to the baseline for protein, fat,

vitamins B_1/B_2/C, calcium, iron, and dietary fiber, and these percentages remained significantly high seven months after the intervention. No significant differences from baseline were observed for any of the other nutrients. In contrast, in the control group, the percentage of children whose choices fit within the appropriate range of Vitamin B_2 per 100 kcal decreased from Baseline 1 to Baseline 2. There was no difference between Baseline 1 and Baseline 2 for energy or any other nutrient. In the baseline comparison between the intervention and control groups, the percentage of children with a vitamin B_2 intake within the appropriate range was significantly higher in the control group.

4. Discussion

Previous studies have used dietary surveys that rely on the memories of children and their parents as a method of validating the effects of dietary education, but several issues have been suggested with these methods, including that the abilities of children limit the accuracy of dietary surveys [13,14] and parents do not have a sufficient grasp of the types and quantities of food that their children consume [16]. The method used in this study of actually having children select real snacks was useful in avoiding these issues.

Few studies have evaluated the effects of snack-centered dietary education interventions for children. Matvienko et al [15]. administered snack-centered dietary education lessons to children aged 6 and 7, asked the children to select two food items and one drink from seven food items and three drink options (items with high and low nutritional values), and evaluated the snack quality on the basis of the number of items with high nutritional value. Although the quality of the selected snacks was evaluated in this study, the quantity could not be evaluated.

Furthermore, only a few types of foods and drinks were offered, and the children were only allowed to select two foods and one drink. This design may differ from how children freely select snacks.

In the present study, children were offered 23 types of snacks that are familiar to Japanese children, and they were allowed to freely select one day's worth of snacks without any limitations on the number or combination of items. The ability of children to select the proper quality and quantity of snacks was evaluated by adding the energy and nutrient contents of the selected snacks. A large percentage of children in both the intervention and control groups selected too many snacks in the baseline test. However, the amount of snacks selected by the children in the intervention group decreased after the intervention. Furthermore, this improvement was still observed seven months after the intervention ended. In contrast, there was no difference in the energy contents of the snacks selected by the control group. This indicated that the decrease in the energy of the snacks that was observed in the intervention group was not because of seasonal variation or the growth of the children, but rather was an effect of dietary education. Moreover, in the dietary education lessons in this study, the appropriate amount of snacks was compared with a bowl of rice. A bowl of rice contains approximately 200 kcal of energy [18], which matched the intervention goal of 200 kcal for one day's worth of snacks. Rice is a staple food for the Japanese, and even children eat it regularly and are familiar with it; therefore, it was easy for them to understand snack portions compared with rice portions. In addition, the decrease in the energy contents that were observed after the intervention was because of a decrease in the number of foods that were selected from the low nutritional value food group that mainly comprised sugary and fatty foods. Meanwhile, the number of some foods in the high nutritional value food group increased. In the dietary education lessons, children learned that snacks that taste sweet have a lot of sugar; snacks that feel greasy have a lot of fat; and snacks, such as fruit, sweet potatoes, and milk, have a high nutritional value. They were explained that they would be healthier if they ate more healthy snacks than snacks with low nutritional value. Children considered quality when selecting snacks because they learned these things. The nutrient densities of vitamins, iron, and dietary fiber per 100 kcal of snacks increased after the intervention, and the selections were still high seven months after the intervention. This suggested that the effects of this dietary education program were not temporary but rather persisted for at least half a year.

In the intervention group, the number of fruits, such as oranges and bananas that were selected increased after the intervention despite the decreased energy content of the snacks. Other intervention studies have also reported that it is easier to increase fruit intake than vegetable intake in children [19]. Taste preferences have been reported to be the most influential factor in the food selections of children aged 6–12 [20], and it can be inferred that compared with vegetables, the taste of fruits and other foods with high nutritional value that were included in the snacks used in this study was more acceptable to children. Self-efficacy skills have been shown to be important in the modification of food selection behaviors in humans [21]. Because many children do not like the taste of vegetables, it is important to not center dietary education for young children on vegetables and instead build self-efficacy skills by first using foods, such as snacks that have an acceptable taste to children. Once this foundation has been laid, the next steps can be taken.

Our study has some limitations. The first is that it was not randomized. It would have been difficult to divide the subjects into the groups during the same school year because of educational considerations. Therefore, some items differed between the intervention and control groups at baseline. Second, although children selected snacks during the snack selection test, they did not actually eat them. In the future, a study should be conducted to determine the snacks that children select and eat at home. In addition, studies have shown that the snack purchases of children are influenced by television commercials [22], price, and friends [23], but this was not confirmed in the present study. These limitations should be considered when interpreting the results. However, this study uncovered that dietary education that uses snacks may possibly be effective. Furthermore, one strong point of this study was that the quality and quantity of the snacks was directly evaluated by having children select snacks rather than by questionnaires for parents or dietary surveys that rely on the memories of children.

5. Conclusion

Snacks are a category of food that young children like and can select for themselves. This study validated the hypothesis that taking advantage of the characteristics of snacks to educate young children about food is effective in improving the ability of children to select snacks, suggesting that snack-centered dietary education is effective in improving the ability of young children to select snacks. Additional works should be conducted to determine the snacks that children select and eat at home.

Acknowledgement

We would like to thank all children, their parents/guardians, and school personnel for participating in this study.

Statement of Competing Interest

The authors have no competing interests.

List of Abbreviations

RDA; recommended dietary allowances
AI; adequate intakes
ANOVA; analysis of variance

References

[1] Ogden, C.L., Carroll, M.D., Kit, B.K. and Flegal, K.M., "Prevalence of childhood and adult obesity in the United States, 2011-2012," *JAMA*, 311 (8). 806-814. Feb. 2014.

[2] Lazzeri, G., Rossi, S., Kelly, C., Vereecken, C., Ahluwalia, N. and Giacchi, M.V., "Trends in thinness prevalence among adolescents in ten European countries and the USA (1998-2006): a cross-sectional survey," *Public Health Nutr*, 24. 1-9. Sep. 2013.

[3] Inokuchi, M., Matsuo, N., Takayama, J.I. and Hasegawa, T., "Trends in thin body stature among Japanese male adolescents, 2003-2012," *Ann Hum Biol*, 41 (3). 277-281. May. 2014.

[4] Lien, N., Lytle, L.A. and Klepp, K.I., "Stability in consumption of fruit, vegetables, and sugary foods in a cohort from age 14 to age 21," *Prev Med*, 33 (3). 217-226. Sep. 2001.

[5] Skinner, J.D., Carruth, B.R., Wendy, B. and Ziegler, P.J., "Children's food preferences: a longitudinal analysis," *J Am Diet Assoc*, 102 (11). 1638-1647. Nov. 2002.

[6] Larson, N., Fulkerson, J., Story, M. and Neumark-Sztainer, D., "Shared meals among young adults are associated with better diet quality and predicted by family meal patterns during adolescence," *Public Health Nutr*, 16 (5). 883-893. May. 2013.

[7] Jones, S.C. and Kervin, L., "An experimental study on the effects of exposure to magazine advertising on children's food choices," *Public Health Nutr*, 14 (8). 1337-1344. Aug. 2011.

[8] Takeichi, H., Taniguchi, H., Fukinbara, M., Tanaka, N., Shikanai, S., Sarukura, N., Hsu, T.F., Wong, Y. and Yamamoto, S., "Sugar intakes from snacks and beverages in Japanese children," *J Nutr Sci Vitaminol*, 58 (2). 113-117. 2012.

[9] Johnson, G.H. and Anderson, G.H., "Snacking definitions: impact on interpretation of the literature and dietary recommendations," *Crit Rev Food Sci Nutr*, 50 (9). 848-871. Oct. 2010.

[10] Mercille, G., Receveur, O. and Macaulay, A.C., "Are snacking patterns associated with risk of overweight among Kahnawake schoolchildren?," *Public Health Nutr*, 13 (2). 163-171. Feb. 2010.

[11] Melnik, T.A., Rhoades, S.J., Wales, K.R., Cowell, C. and Wolfe, W.S., "Food consumption patterns of elementary schoolchildren in New York City," *J Am Diet Assoc*, 98 (2). 159-164. Feb. 1998.

[12] Cullen, K.W., Eagan, J., Baranowski, T., Owens, E. and de Moor, C., "Effect of a la carte and snack bar foods at school on children's lunchtime intake of fruits and vegetables," *J Am Diet Assoc*, 100 (12). 1482-1486. Dec. 2000.

[13] Baxter, S.D., Thompson, W.O., Litaker, M.S., Frye, F.H. and Guinn, C.H., "Low accuracy and low consistency of fourth-graders' school breakfast and school lunch recalls," *J Am Diet Assoc*, 102 (3). 386-395. Mar. 2002.

[14] Warren, J.M., Henry, C.J., Livingstone, M.B., Lightowler, H.J., Bradshaw, S.M. and Perwaiz, S., "How well do children aged 5-7 years recall food eaten at school lunch?," *Public Health Nutr*, 6 (1). 41-47. Feb. 2003.

[15] Matvienko, O., "Impact of a nutrition education curriculum on snack choices of children ages six and seven years," *J Nutr Educ Behav*, 39 (5). 281-285. Sep. 2007.

[16] Hammond, J., Nelson, M., Chinn, S. and Rona, R.J., "Validation of a food frequency questionnaire for assessing dietary intake in a study of coronary heart disease risk factors in children," *Eur J Clin Nutr*, 47 (4). 242-250. Apr. 1993.

[17] Yoshiike, N., Hayashi, F., Takemi, Y., Mizoguchi, K. and Seino, F., "A new food guide in Japan: the Japanese food guide Spinning Top," *Nutr Rev*, 65 (4). 149-154. Apr. 2007.

[18] The Committee for Science and Technology Council Subcommittee Resources Survey of the Ministry of Education, Culture, Sports, Science and Technology in Japan. *Standard Tables of Food Composition in Japan*, *5th ed*., Ishiyaku Publishers, Tokyo, 2001, 1-508.

[19] Burchett, H., "Increasing fruit and vegetable consumption among British primary schoolchildren: a review," *Health Educ*, 103 (2). 99-109. 2003.

[20] Blanchette, L. and Brug, J., "Determinants of fruit and vegetable consumption among 6-12-year-old children and effective interventions to increase consumption," *J Hum Nutr Diet*, 18 (6). 431-443. Dec. 2005.

[21] Reynolds, K.D., Yaroch, A.L., Franklin, F.A. and Maloy, J., "Testing mediating variables in a school-based nutrition intervention program," *Health Psychol*, 21 (1). 51-60. Jan. 2002.

[22] Kelly, B., Smith, B., King, L., Flood, V. and Bauman, A., "Television food advertising to children: the extent and nature of exposure," *Public Health Nutr*, 10 (11). 1234-1240. Nov. 2007.

[23] Salvy, S.J., Kluczynski, M.A., Nitecki, L.A. and O'Connor, B.C., "Peer influence on youth's snack purchases: a laboratory analog of convenience store shopping," *Eat Behav*, 13 (3). 233-239. Aug. 2012.