

# Adolescents' Estimation of Energy Content of Standard Portion Size of Foods and Its Association with Body Mass Index

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## ABSTRACT

The purpose of this study is to identify the adolescents' knowledge of the energy content of the standard portion size of foods and to investigate the association between their knowledge and energy intake and also body mass index (BMI). A total of 251 middle school adolescents participated in this study. Participants' knowledge was assessed based on their estimation of the energy content of the standard portion size of foods. To estimate the energy intake of the subjects, 24-h recall was used. The percentage of participants who accurately estimated (that is within 20% of the true value) the energy content of the standard portion size was calculated for each of the 32 typical foods. The food for which the most participants revealed the accurate estimation was cooked rice (39.5%). The proportion of students who overestimated the energy contents was highest for vegetables (98%), and oils and sugar (90%). The female students were more likely than males to provide the accurate estimation of energy contents for standard portion size of foods. After adjusting for age and sex, the estimation level ( $[\text{estimation value}/\text{true value}] \times 100$ ) of the energy content of some foods had a significant positive relationship with BMI, but had no significant relationship with reported energy intake. From these results, we concluded that the knowledge of energy content of food was poor among adolescents, with some gender difference, and that their estimation of the calorie contents of foods increased along with their BMI.

**Keywords:** Knowledge of Energy Content; Portion Size; Energy Intake; BMI; Adolescents

## 1. Introduction

In order to assist people in meeting daily nutrient recommendations, dietary intake is interpreted as two terms, serving size (standard portion size) and portion size. The serving size of a food refers to the recommended amount of food to be taken according to public guidelines on dietary intake such as the Food Pyramid. On the other hand, portion size refers to the amount of food that an individual decides to take at one time, and this is not necessarily the same as the serving size. A number of studies show that an increase in the portion size contributes to the rise in obesity [1-3]. In order to prevent obesity or underweight, therefore, an individual should choose the right amount of food and have accurate understanding of the standard portion size. In many countries, therefore, the government establishes a recommended portion size to help people meet proper energy requirements [4-6]. The food guide of the Korean Dietary Reference Intakes also provides the standard portion size

of a limited number of typical Korean foods [7].

The nutrition education provided for Korean middle school students in home economics class suggests a standard diet including various nutrients based on nutritional intake standards and five basic food groups. Nevertheless, the standard portion size of various foods or portion size estimation is not included in regular classes but only in the appendix. Students are not given an opportunity to actually weigh various foods, for it is replaced by theoretical classes. Moreover, such education fails to provide the nutritional content of foods but only lists food sources of nutrients, which greatly limits students' ability to use the knowledge in deciding what to eat and how much to eat. That is, the current education cannot help students to figure out the calories of the standard portion size for common foods and, as a result, they may eat too much or little compared to the recommended amounts of food [8,9].

Nutritional education program should not only provide general knowledge but also actually help students make the right decision about food intake. From this point of

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view, adolescents who are more likely to choose what to eat by themselves need help in understanding amounts and the calorie content of foods. In particular, the instruction should be practical, rather than focused on theories, utilizing visual materials such as actual pictures or food models. To that end, we need to first analyze adolescents' knowledge regarding the energy content of the standard portion sizes of typical Korean foods in the current nutrition education environment.

The purpose of this study is 1) to identify the knowledge of the energy content of standard portion size of 32 typical Korean foods; 2) to investigate the relation between their estimation and reported energy intake and body mass index (BMI). Finally we provide data to address improving nutritional education programs for adolescents.

## 2. Materials and Methods

### 2.1. Subjects and Period

We conducted a preliminary survey on June 28, 2010 and modified and improved the questionnaire in order to distribute 360 copies to male and female students in a middle school, located in Seoul, Korea, on July 2. We collected 358 copies and excluded incomplete ones. Finally, a total of 251 copies were used for statistical analysis.

### 2.2. Methods and Contents

The questionnaire consisted of 3 questions for general information including body weight and height, and 32 about knowledge of energy content of the standard portion size of 32 typical Korean foods. The questionnaire also included the 24-hour recall method.

Body weight and height were obtained using a self-reported data. In order to conduct the survey on the knowledge of the energy content of standard portion size of foods, we provided 32 types of typical Korean foods with describing in household measures about the portion size of each food and allowed the subjects to freely describe energy content of each food. The 32 food items were decided based on the standard portion size of major foods provided in the home economics text book used in middle schools and the food guide of the Korean Dietary Reference Intakes [7].

The dietary survey on the types and amounts of foods taken for breakfast, lunch, dinner, and for snacks was carried out by using the 24-hour recall method by professionally trained dietitians from the morning and until bedtime on the day before the survey. Food models and pictures were used to help participants accurately recall the food they had eaten. The daily energy intake was analyzed by CAN-Pro 3.0 (The Korean Nutrition Society,

2005).

### 2.3. Statistical Analysis

The data were analyzed by SAS (version 9.1) so as to calculate the frequency, percentage, average, and standard deviation according to the gender. Participants' energy estimation level was calculated by the following equation; (estimation value of the energy content of each food/true value)  $\times$  100. Based on the results of the existing research, the participants were divided into the following 3 categories: under calorie estimation (the estimation was under 20% and over from the actual calories of the standard portion size of each food), accurate calorie estimation (the estimation was within the  $\pm 20\%$  of the actual calories of the standard portion size of each food), and over calorie estimation (the estimation was over 20% and more of the actual calories of the standard portion size of each food) [8,9]. For the significance analysis, we used the  $\chi^2$ -test and Student's t-test. We analyzed the partial correlation coefficients among the calorie estimation level, energy intake, and BMI, after adjusting for age only or age and sex (in the case of total subjects). All statistical significance was considered at the level of  $\alpha < 0.05$ .

## 3. Results

### 3.1. General Characteristics of the Subjects

**Table 1** shows the general information of the subjects. The average age of participant was 14.9 years old. The height ( $p < 0.001$ ) and weight ( $p = 0.001$ ) were significantly higher in the male group than in the female group. Regarding the BMI ( $19.9 \text{ kg/m}^2$  in male vs.  $19.73 \text{ kg/m}^2$  in female), however, there was no significant difference between the two groups.

The energy intake was significantly higher in the male group than in the female group ( $2213.6 \text{ kcal}$  vs.  $1872.9 \text{ kcal}$ ,  $p < 0.001$ ). The energy intake based on the estimated energy requirement was 85.7% in the male group and 93.6% in the female group, showing a significant difference ( $p = 0.002$ ).

### 3.2. Knowledge of Calorie Content about Standard Portion Size of 32 Typical Korean Foods

**Table 2** and **Figure 1** show the students' knowledge levels of the calorie content of 32 typical foods. The food group for which the most participants provided the accurate estimation was grains/starches (25.6%), followed by dairy (22.5%) and protein foods (15.6%).

The food for which the most participants provided the accurate estimation was cooked rice (35.5%), followed

**Table 1. Age, anthropometric measurements and daily energy intake of the subjects.**

Variables	Total subjects (n = 251)	Boys (n = 131)	Girls (n = 120)	Significance*
Age (yrs)	14.9 ± 0.8	14.9 ± 0.8	15.0 ± 0.8	NS
Height (cm)	162.2 ± 7.9	164.6 ± 8.9	159.6 ± 5.7	p < 0.001
Weight (kg)	52.3 ± 10.0	54.3 ± 10.9	50.3 ± 8.4	p = 0.001
BMI (kg/m <sup>2</sup> )	19.8 ± 3.0	19.9 ± 3.1	19.7 ± 3.0	NS
Energy intake (kcal)	2049.7 ± 454.9	2213.6 ± 453.5	1872.94 ± 386.6	p < 0.001
% of EER	89.5 ± 19.0	85.7 ± 17.9	93.6 ± 19.3	p = 0.002

Values are expressed as mean ± SD. \*Significance between boys and girls as determined by Student's t-test. NS: Not significant. EER: Estimated energy requirement.

**Table 2. Estimation of energy contents of standard portion size of 32 typical Korean foods.**

Variables	Criteria of estimation	Total (n = 251)	Boys (n = 131)	Girls (n = 120)	Significance*
Grains and starches					
	Under	29.9	36.7	22.5	p = 0.042
Cooked rice (210 g, 286 kcal) <sup>†</sup>	Accurate	35.5	30.5	40.8	
	Over	34.6	32.8	36.7	
	Under	52.2	58.8	45.0	p = 0.005
Noodles (100 g, 375 kcal)	Accurate	29.5	20.6	39.2	
	Over	18.3	20.6	15.8	
	Under	53.4	47.3	60.0	NS
Bread (100 g, 283 kcal)	Accurate	21.9	27.5	15.8	
	Over	24.7	25.2	24.2	
	Under	13.2	16.0	10.0	NS
Rice cake (50 g, 110 kcal)	Accurate	24.3	23.7	25.0	
	Over	62.5	60.3	65.0	
	Under	13.6	11.5	15.8	NS
Chestnut (60 g, 97 kcal)	Accurate	23.9	22.1	25.8	
	Over	62.5	66.4	58.4	
	Under	15.6	22.1	8.3	p = 0.008
Potato (130 g, 86 kcal)	Accurate	17.5	17.6	17.5	
	Over	66.9	60.3	74.2	
	Under	12.8	13.0	12.5	NS
Cereal (30 g, 116 kcal)	Accurate	24.3	21.4	27.5	
	Over	62.9	65.5	60.0	
	Under	19.9	25.9	13.3	p = 0.032
Sweet potato (90 g, 115 kcal)	Accurate	27.9	23.7	32.5	
	Over	52.2	50.4	54.2	

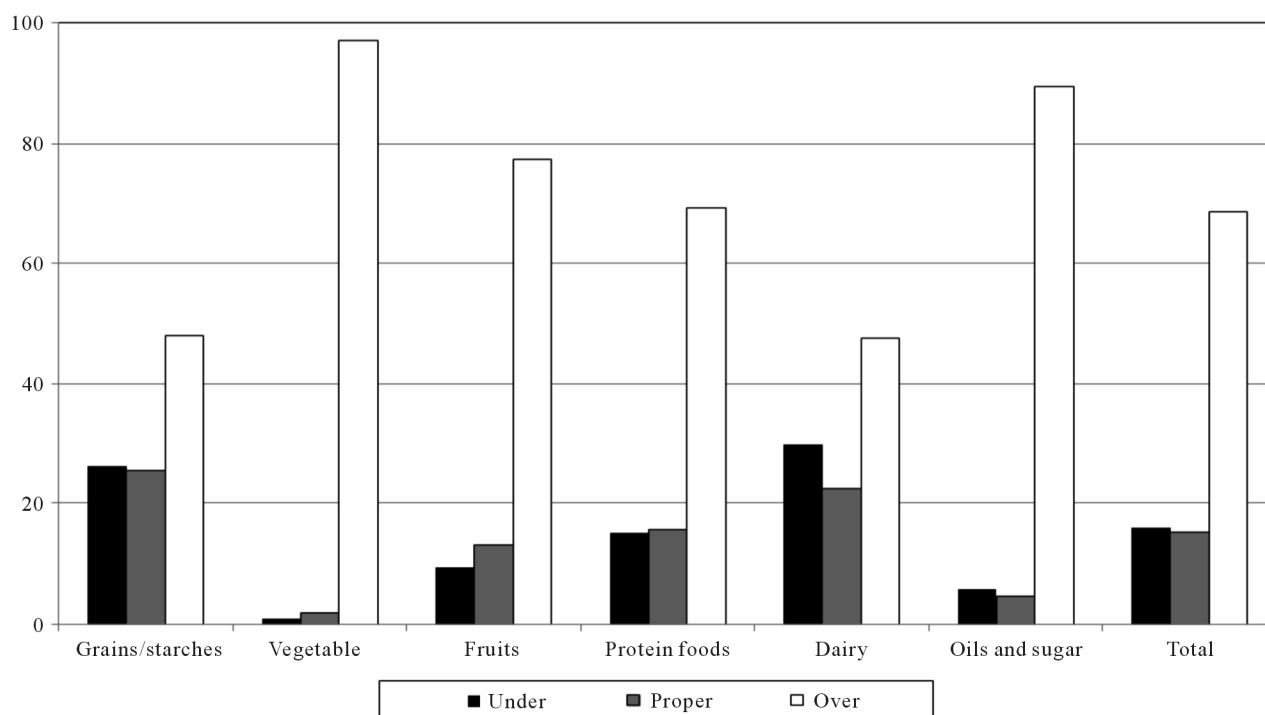
**Continued**

Vegetables					
	Under	1.2	0.0	2.5	p = 0.022
Spinach (70 g, 19 kcal)	Accurate	2.8	0.8	5.0	
	Over	96.0	99.2	92.5	
	Under	2.4	2.3	2.5	NS
Bean sprouts (70 g, 23 kcal)	Accurate	6.0	7.6	4.2	
	Over	91.6	90.1	93.3	
	Under	0.8	0.8	0.8	NS
Kimchi (40 g, 7 kcal)	Accurate	0.0	0.0	0.0	
	Over	99.2	99.2	99.2	
	Under	0.4	0.4	0.0	NS
Mushroom (30 g, 8 kcal)	Accurate	0.0	0.0	0.0	
	Over	99.6	99.6	100.0	
	Under	0.0	0.0	0.0	NS
Seaweed (30 g, 8 kcal)	Accurate	0.4	0.8	0.0	
	Over	99.3	99.2	100.0	
Fruits					
	Under	12.0	15.3	8.3	NS
Apple (100 g, 57 kcal)	Accurate	10.0	9.9	10.0	
	Over	78.0	74.8	81.7	
	Under	4.0	6.1	1.7	p = 0.027
Mandarin orange (100 g, 47 kcal)	Accurate	13.6	9.2	18.3	
	Over	82.4	84.7	80.0	
	Under	9.6	12.2	6.7	NS
Oriental melon (200 g, 52 kcal)	Accurate	11.2	9.9	12.5	
	Over	79.2	77.9	80.8	
	Under	6.4	5.3	7.5	NS
Grape (100 g, 55 kcal)	Accurate	10.4	10.7	10.0	
	Over	83.2	84.0	82.5	
	Under	15.1	16.8	13.3	NS
Orange juice (200 g, 84 kcal)	Accurate	20.7	22.9	18.3	
	Over	64.1	60.3	68.4	
Protein foods					
	Under	9.2	12.2	5.8	NS
Pork (60 g, 108 kcal)	Accurate	12.4	12.2	12.5	
	Over	78.4	75.6	81.7	
	Under	8.4	7.6	9.2	NS
Chicken (60 g, 108 kcal)	Accurate	15.5	13.8	17.5	
	Over	76.1	78.6	73.3	

**Continued**

	Under	16.7	11.5	22.5	p = 0.022
Mackerel (50 g, 90 kcal)	Accurate	13.6	11.5	15.8	
	Over	69.7	77.0	61.7	
	Under	18.7	18.3	19.2	NS
Tofu (80 g, 67 kcal)	Accurate	18.7	20.6	16.7	
	Over	62.6	61.1	64.1	
	Under	22.7	19.9	25.8	NS
Egg (50 g, 79 kcal)	Accurate	17.9	15.3	20.8	
	Over	59.4	64.8	53.4	
	Dairy				
	Under	31.9	39.7	23.3	p = 0.007
Milk (200 g, 120 kcal)	Accurate	29.5	29.8	29.2	
	Over	38.6	30.5	47.5	
	Under	7.6	7.6	7.5	NS
Cheese (20 g, 62 kcal)	Accurate	18.7	16.0	21.7	
	Over	73.7	76.4	70.8	
	Under	33.1	25.2	41.7	p = 0.014
Yogurt (110 g, 109 kcal)	Accurate	25.9	26.7	25.0	
	Over	41.0	48.1	33.3	
	Under	21.1	16.8	25.8	NS
Liquid yogurt (150 g, 97 kcal)	Accurate	19.1	16.8	21.7	
	Over	59.8	66.4	52.5	
	Under	56.2	56.5	55.8	NS
Ice cream (100 g, 211 kcal)	Accurate	19.1	17.6	20.8	
	Over	24.7	25.9	23.3	
	Oils and sugar				
	Under	7.6	1.5	14.2	p < 0.001
Cooking oil (5 g, 44 kcal)	Accurate	10.8	4.6	17.5	
	Over	81.6	93.9	68.3	
	Under	3.6	1.5	5.8	p = 0.011
Butter (5 g, 37 kcal)	Accurate	3.2	0.8	5.8	
	Over	93.2	97.7	88.4	
	Under	4.4	2.3	6.7	p = 0.038
Mayonnaise (5 g, 35 kcal)	Accurate	5.6	3.1	8.3	
	Over	90.0	94.6	85.0	
	Under	5.2	2.3	8.3	p = 0.049
Sugar (10 g, 39 kcal)	Accurate	1.6	0.8	2.5	
	Over	93.2	96.9	89.2	

Values are expressed as percentage of subjects (%). \*Significant difference between boys and girls as determined by  $\chi^2$ -test. †One portion size and its energy content. NS: Not significant.



**Figure 1. Estimation of calorie contents of one portion size of foods according to the food groups.**

by noodles (29.5%), milk (29.5%), and sweet potatoes (27.9%). The proportion of subjects who overestimated the calorie content was highest for vegetables (98%), oils and sugar (90%), and fruits (77%). In the protein foods, 15.6% of the participants had accurate knowledge about the energy content of each protein food item. About 90% of the participants thought that the calorie contents of oils and sugar was higher than their actual calorie contents.

Among the 32 typical foods, there was a significant gender difference in the estimation of the calories of 13 foods. Compared with the male students, a higher proportion of female students provided the accurate calorie estimation for cooked rice ( $p < 0.05$ ), noodles ( $p < 0.01$ ), sweet potatoes ( $p < 0.05$ ), spinach ( $p < 0.05$ ), mandarin orange ( $p < 0.05$ ), and mackerel ( $p < 0.05$ ). A higher proportion of female students provided calorie over-estimation for potato ( $p < 0.01$ ) and milk ( $p < 0.01$ ). For yogurt ( $p < 0.05$ ), cooking oil ( $p < 0.001$ ), butter ( $p < 0.05$ ), mayonnaise ( $p < 0.05$ ), and sugar ( $p < 0.05$ ), a higher proportion of male students provided calorie over-estimation than that of female students.

### 3.3. Relationship between the Calorie Estimation of Portion Size and Energy Intake, and BMI

The relationship between estimation of calorie content for portion size of food and energy intake, and also BMI is shown in **Table 3**. From the results of using total subjects, there were significant positive correlations between

BMI and the calorie estimation level of noodles ( $p < 0.05$ ), potato ( $p < 0.01$ ), sweet potato ( $p < 0.05$ ), *kimchi* ( $p < 0.05$ ), orange juice ( $p < 0.05$ ), cheese ( $p < 0.01$ ), yogurt ( $p < 0.01$ ), ice cream ( $p < 0.01$ ), cooking oil ( $p < 0.05$ ), and sugar ( $p < 0.05$ ). In the male group, BMI had a significant positive relationship with the calorie estimation level of cooked rice ( $p < 0.05$ ), potato ( $p < 0.05$ ), sweet potato ( $p < 0.05$ ), and orange juice ( $p < 0.05$ ). In the female group, BMI had a significant positive relationship with the calorie estimation level of noodles ( $p < 0.05$ ), cereal ( $p < 0.05$ ), *kimchi* ( $p < 0.05$ ), milk ( $p < 0.001$ ), yogurt ( $p < 0.01$ ), liquid yogurt ( $p < 0.05$ ), ice cream ( $p < 0.05$ ), cooking oil ( $p < 0.05$ ), and mayonnaise ( $p < 0.05$ ). There was no significant correlation between energy intake and calorie estimation level, for both males and females.

## 4. Discussion

In this study, we investigated the knowledge of the energy content of standard portion size of 32 typical Korean foods among middle-school adolescents in the current nutrition education environment in Korea. According to the results, the knowledge of the energy content of food was poor among the middle-school adolescents. The percentage of participants who accurately estimated the energy content of the standard portion size was calculated for each of the 32 typical foods, and then the total of these percentages (ranging from 0% for *kimchi* and

**Table 3. Pearson's partial correlation coefficient between estimation of calorie contents of portion size of foods and energy intake, and BMI.**

Calorie estimation <sup>†</sup>	Total (n = 251)		Boys (n = 131)		Girls (n = 120)	
	Energy	BMI	Energy	BMI	Energy	BMI
Cooked rice	-0.0329 <sup>††</sup>	0.1100	0.0140	0.1929 <sup>*</sup>	-0.0904	0.1040
Noodles	-0.0495	0.1435 <sup>*</sup>	-0.0203	0.1606	0.0916	0.2507 <sup>*</sup>
Bread	0.0147	0.0973	0.1162	0.1687	-0.1304	0.0195
Rice cake	-0.0102	0.1184	0.0694	0.1830	-0.1174	0.0276
Chestnut	0.0025	-0.0124	0.0955	-0.0237	-0.0740	-0.0214
Potato	-0.0151	0.2302 <sup>**</sup>	-0.0160	0.2086 <sup>*</sup>	-0.0137	0.1685
Cereal	-0.1171	0.0273	-0.1245	-0.0293	-0.1102	0.2507 <sup>*</sup>
Sweet potato	-0.2641	0.1348 <sup>*</sup>	0.0062	0.2397 <sup>*</sup>	-0.0678	-0.0089
Spinach	-0.0259	0.0031	-0.0647	-0.0796	0.0422	0.1568
Bean sprout	-0.0128	0.1030	0.0026	0.1492	-0.0259	0.1136
Kimchi	0.1144	0.1777 <sup>*</sup>	0.0565	0.1260	0.1763	0.2085 <sup>*</sup>
Mushroom	0.0555	-0.0543	0.0305	-0.1495	0.1351	0.0917
Seaweed	0.0530	0.0374	0.0576	0.0557	0.0464	0.0508
Apple	0.0234	-0.0401	0.0077	-0.0418	0.0842	-0.0984
Mandarin orange	-0.0477	-0.0437	-0.0747	-0.0308	-0.0037	-0.0271
Oriental melon	0.0442	0.0152	0.0232	0.0826	0.0670	-0.0367
Grape	0.0734	-0.0174	0.0952	-0.0228	0.0400	0.0317
Orange juice	0.0187	0.1537 <sup>*</sup>	0.0474	0.2018 <sup>*</sup>	-0.0136	0.0359
Pork	-0.0598	0.0502	0.0098	0.1343	-0.1503	-0.0646
Chicken	-0.0074	-0.0594	-0.0293	0.0001	0.0167	-0.1765
Mackerel	-0.0433	0.1032	-0.0437	0.1118	-0.0427	0.0605
Tofu	0.0506	0.0741	0.0359	0.0809	0.0722	0.0256
Egg	0.0819	0.0022	0.1278	-0.0241	0.0209	0.1261
Milk	0.1215	0.1007	0.1663	-0.0926	0.0706	0.3729 <sup>**</sup>
Cheese	-0.0031	0.2210 <sup>**</sup>	0.0187	0.1193	-0.0277	0.1292
Yogurt	0.1252	0.2132 <sup>**</sup>	0.1404	0.0765	0.1161	0.3638 <sup>**</sup>
Liquid yogurt	-0.0602	0.0497	0.0718	-0.0062	-0.1303	0.2634 <sup>*</sup>
Ice cream	-0.0027	0.1727 <sup>**</sup>	-0.0069	0.1135	0.0031	0.2424 <sup>*</sup>
Cooking oil	0.0130	0.1268 <sup>*</sup>	0.0613	0.1698	-0.0647	0.2519 <sup>*</sup>
Butter	-0.0751	0.0259	-0.0586	-0.0293	-0.1003	0.0801
Mayonnaise	0.0100	0.1122	0.0170	-0.0281	0.0035	0.2465 <sup>*</sup>
Sugar	0.0196	0.1465 <sup>*</sup>	0.0330	0.0810	0.0047	0.1743
Average of 32 items	0.0479	0.1132	0.0432	0.0218	0.0548	0.1965 <sup>*</sup>

<sup>†</sup>Calorie estimation (%) = (Subjects' estimation of calorie contents of the standard portion size of each food/the actual calorie contents) × 100; <sup>††</sup>Adjusted by age and sex in total subjects, adjusted by age in each male and female subjects. \* p < 0.05, \*\* p < 0.01.

mushroom to 35.5% for cooked rice) were averaged to be 15.3%. This finding suggests that knowledge of the energy content of food in middle school adolescent is undesirably lacking.

The participants' knowledge of calorie content of the portion size tended to differ according to the various food groups. The food groups for which the most students provided the accurate estimation was grains/starches (25.6%), followed by dairy (22.5%) and protein foods (15.6%). Most of the students thought that the calorie contents of vegetables, oils and sugar, and fruits were higher than their actual calorie contents.

Regarding the grains/starches, about 36% of the students had knowledge of the calorie content of the standard portion size for a bowl of cooked rice. In the case of noodles and bread, over 50% of the participants estimated that the calorie content was lower than the actual calorie contents. According to the 2009 National Health and Nutrition Examination Survey (NHANES) in Korea, grains were the greatest source of energy for the Korean people [10]. In particular, people ate rice 2.6 times a day and consumed 182.3 g of rice a day, showing the greatest frequency and largest quantities among all foods. As such, the diet of the Korean people heavily depends on grains, but just 36% of this study subjects gave an accurate energy contents for rice, which may cause an imbalance of nutrients. Therefore, teenagers need to be taught about the standard portion size of grains/starches in order to consume carbohydrates, which are the major source of energy, in a balanced manner.

Particularly, *kimchi* is one of the most frequently consumed vegetables in Korea. However, most of the students overestimated the calorie content of *kimchi*, demonstrating little knowledge of the calorie content of this food. As for milk a relatively high percentage (about 30%) of the students accurately estimated the calorie content of milk. Due to recognizing the importance of dairy foods as a source of calcium, home and school meals frequently include milk to support proper growth in adolescents, and milk is usually served in a portion-size container including nutrition label, which may explain the relatively high knowledge of calorie content of milk.

An average of 97%, 90%, and 77% of the participants thought that the calorie contents of vegetables, oils and sugar, and fruits were higher than their actual calorie contents, respectively. Through these results, it can be inferred that the students thought that oils and sugar contained a high number of calories regardless of standard portion size; furthermore, they overestimated the calorie contents of vegetables and fruits due to the large portion size of these low calorie density foods. Therefore, in nutrition education programs for adolescents, both the

proper portion size and calorie content of each food should be emphasized.

This study showed a significant gender difference in the calorie estimation levels of 19 items among the 32 foods. Regardless of statistical significance, the female students had a higher rate of accurate-estimation for 21 foods. This result was consistent with previous studies showing that the nutrition knowledge score of girls was higher than that of boys [11-13].

According to the recent studies, calorie awareness of food may affect the food choice. Roberto *et al.* found that participants who read posted calorie information ordered fewer calories [14], and Tandon *et al.* reported that awareness of calorie information had an effect on parents' food choices for young children but no effect on the adults' choice [15]. It was also found that customers who reported using the calorie information after chain restaurants were required to show the energy contents of all items on their menus purchased an average of 106 fewer calories compared with customers who did not see or did not use such information [16]. Even though the setting of these studies was restaurants, unlike the present study's setting, calorie awareness of food can potentially affect energy intake and food choice by informed decision making. However, in this study, there was no significant relationship between the knowledge of calorie contents of portion size and energy intake, in both boys and girls. From these results, we infer the following: first, the adolescents' knowledge of calorie contents of standard portion size of foods was too low to affect their energy intake; second, they may not apply the knowledge of calorie contents of portion size of foods to their actual dietary intake.

On the other hand, the relative % estimation of the energy contents of some foods had a significant positive relationship with BMI. Despite some differences in food items between boys and girls, students' estimation of the calorie contents of some foods increased along with their BMI increase. This correlation analysis cannot distinguish the clear relationship between accuracy of estimation and BMI, but it does show that knowledge or awareness of calorie contents among middle school adolescents is associated with BMI. Carels *et al.* reported that adults in a weight loss program with a higher BMI were less accurate in energy estimation of individual foods than those with a lower BMI at baseline [17]. Also, the other study carried by Chen *et al.* showed BMI had a significant effect on students' estimation of their recommended daily calorie needs as students with underweight/normal BMI were more accurate [18].

This study has several limitations. First, the number of subjects was small compared with the initial number of respondents as we included only the subjects who pro-



vided non-missing valid data. Second, we did not ask whether the subjects actually knew the calorie contents of the portion size of 32 typical Korean foods or not, as we mainly focused on their estimation level of calorie contents of portion-size foods. Therefore, we could not exactly determine whether the subjects' estimation level was based on knowledge or speculation. Third, we also did not survey whether the subjects used the knowledge of calorie contents when they chose the foods. As subjects' motivation or willingness to apply their knowledge can affect their food choices, this limitation may be another reason for the non-significant relationship between energy intake and the calorie content of food.

## 5. Conclusion

We concluded from the results that the knowledge of energy contents of foods was poor among the middle-school adolescents, with some gender difference, and the relative % estimation of energy contents and BMI were positively correlated. Therefore, in the future, nutrition education programs should give greater attention to improving adolescents' knowledge of calorie contents of foods and to helping them apply this knowledge in order to develop effective dietary plans. Furthermore, nutrition education programs should encourage the adolescents to apply this knowledge to make proper choices of foods so as to maintain ideal body weight.

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