RESEARCH ARTICLE

High School Students' Sugar Intake Behaviors and Consumption of Sugary Processed Food Based on the Level of Sugar-related Nutrition Knowledge in Seoul Area

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ABSTRACT

Objectives: The present study aimed to investigate high school students' sugar intake behaviors, the status of consuming sugary processed foods, the awareness of sugar, and the experience and interest in sugar-related education based on the level of sugar-related nutrition knowledge.

Methods: In this study, five high schools were selected in Seoul, Korea, and a survey was conducted in 400 students on the level of sugar-related nutrition knowledge and sugar intake status. A total of 349 questionnaires were used for the final analysis. For statistical analysis, descriptive statistics was performed; a t-test, χ^2 test, and Friedman test were used for comparative analysis.

Results: The study results showed a positive association between the knowledge level of sugar and the appropriate sugar intake behavior and sugary food choices. The group with more nutrition knowledge on sugar was found to have good eating habits and to eat less sugary food. The main sources of sugar were beverages, confectionary, and bakery goods in the corresponding order, irrespective of the level of nutrition knowledge related to sugar. A significant difference was found in the groups' awareness of the sugar content of the drinks with 89.4% for the higher-knowledge group, and only 81.5% for the lower-knowledge group (p < 0.05). Results also showed that 43.9% of the higher-knowledge group and 36.4% of the lower knowledge group were interested in participating in education on sugar.

Conclusions: This study result indicated the need to help adolescents to avoid excessive sugar intake from only certain favorite foods. Therefore, it is necessary to seek a systematic foundation for participatory education in order for them to maintain a low sugar intake in daily life and lead healthy eating habits by increasing their level of sugar-related information and knowledge.

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KEY WORDS High school students, Sugar-related nutrition knowledge, Sugar intake behavior, Consumption of sugary processed food

Introduction

Sweet foods have become a favorite in all age groups, and the consumption of sugar-added processed foods has increased; thus, sugar intake among Korean people is spiking [1, 2].

The result of analyzing the sugar intake of Korean people showed that sugar intake continuously increased from 2008 to 2010; in particular, adolescents' average daily sugar intake (69.6 g) was about 13% higher than Korean people's average daily sugar intake (61.4 g). When compared with all other age groups, adolescents' sugar intake was the highest. The main source of adolescents' sugar intake included beverages (14.3 g, 20.5%), fruits (10.9 g, 15.7%), and bread products · confectionary · rice cake (8.9 g, 12.8%). Of these, sugar intake from carbonated drinks was the highest among young people aged between 6 and 29 [3]. According to the Korean National Health and Nutrition Examination Survey, the group who drank carbonated drinks or soda had a higher calorie intake than the non-soda drinking group, while their intake levels of vitamin B_2, niacin, vitamin C, calcium, and phosphorus were relatively low [4]. This indicates that too much soda intake can hinder the absorption of essential nutrients.

Sugar intake from various forms of foods can relieve fatigue, refresh the mood, and promote mental stability in adolescents; however, frequent consumption of sugary snack foods can lead to nutritional problems [5, 6]. For example, over-consumption of sugar leads to the release of excessive insulin, which causes low blood sugar, affecting the central nervous system, which uses glucose as its main source of energy; hence, it can cause hyperactivity disorder in adolescents [6, 7]. Moreover, when overweight adolescents consume too much sugar, they can become obese in adulthood and suffer from adult lifestyle diseases such as diabetes or cardiovascular diseases [8]. Therefore, it is necessary for adolescents particularly to make a continuous effort to control their sugar intake in order to maintain their health and prevent lifestyle diseases in adulthood.

Since 2007, Korea has continually conducted educational and promotional activities targeting processed food com-panies and restaurant businesses, to mark and monitor sugar contents and to lower sugar intake [2, 8]. Despite this continuous effort, however, the awareness for sugar reduction and education is still insufficient and particularly sugar-reduction studies targeting high school students, who need to reduce their sugar intake, are extremely rare.

Several research have shown that the higher nutrition knowledge the people had, the more positive they behaved in terms of eating [9-11]. On the other hand, some researcher reported that there was little correlation between nutrition knowledge and eating attitude or behavior [12, 13]. Carruth et al [14] also stated that high nutrition knowledge level was not always expected the proper eating behaviors. From those different points of views, it is difficult to reach a consistent conclusion about the relationship between nutrition knowledge and eating behaviors or attitudes. Nevertheless, right food choice and eating habits could start from accurate nutrition information and knowledge. That is why nutrition education for all generation has been emphasized. Especially, students can learn the right nutrition knowledge through official school education, and nutrition knowledge acquired in that time can steadily be utilized as an adult for good eating habits [15]. Therefore, more study of nutrition knowledge and behaviors among students should.be performed. In this context, this study was con-ducted in order to analyze the sugar-related nutrition knowledge level and the related eating behavior among high school students and investigate whether differences in nutrition knowledge levels make behavioral difference.

In doing so, it aims to suggest educational guidance for lowering sugar intake in homes and in schools.

Methods

1. Subjects

The present study selected five high schools located in Seoul and conducted a survey targeting 400 students. The research survey was conducted by convenient sampling. Five academic high schools of which their dietitians showed high intentions to participate in this research were selected from one of the school districts in Seoul. Before requesting cooperation for the survey, the researcher met with the nutritionists in the participating schools, explained

to them the objective of the research, and gave directions and precautions on how to answer the questionnaire. The research participants were asked to fill out the questionnaire on their own. The survey period was from March 3, 2015 to April 10, 2015. A total of 400 questionnaires were distributed and 375 responses were retrieved (93.8% retrieval rate). After excluding inappropriate responses, a total of 349 questionnaires were used for the final analysis.

2. Knowledge, self-reported behaviors, consumption of the sugary processed foods survey

To evaluate knowledge, self-reported behaviors, and consumption of sugary processed foods, a structured questionnaire was applied, based on other studies relating knowledge, attitude and practices (KAP) studies [16-18] and then administered to the students.

The first part of the questionnaires had the objective of evaluating the level of sugar-related nutrition knowledge of high school students. Fifteen questionnaires were presented; the full score was 15 points with 1 point for each correct answer and 0 points for incorrect answers. A higher score means higher nutrition knowledge. Categories of sugar-related topics include concept & characteristics of sugar (4 questions), sugar & food (4 questions), sugar and health (4 questions) and importance of sugar reduction (3 questions). Sugar intake behavior is formed of eight questions, and was created based on previous studies of adolescents' sugar intake and meal consumption, which include studies of Kim [16], Seo [17], and Yoo [18]. Questions were asked in a 5point Likert scale. In terms of a reliability of these questions, the alpha coefficient for eight questions was .708, suggesting that the questions have acceptable consistency. In order to measure the status of consuming sugary processed foods, intakes/week of sugary processed foods sold in the market was examined after being divided into the 3 categories of confectionary (3 kinds), bakery product (3 kinds) and beverage (5 kinds). A question regarding the need and demand for sugar reduction education was also asked in an attempt to measure the need for education as part of the effort to reduce sugar-intake.

3. Statistical analysis

The survey data were analyzed using SPSS 22.0. In order to identify the general characteristics of survey participants and the frequency of daily snack consumption, frequency analysis was performed; with regard to the sugar intake behavior, and consumption of sugary processed foods, the present study used descriptive statistics analysis. In order to check the reliability of the sugar intake behavior questions, Cronbach's alpha was analyzed. A *t-test* was used in order to analyze the differences in the status of sugar intake attitudes or behaviors, and sugary processed food consumption habits based on the level of sugar-related nutrition knowledge. In addition, to identify categorical data such as the status of experience or interest in sugar-related nutrition education and the preferred learning methods based on the level of sugar-related nutrition knowledge, a Chi-square analysis was performed. With regard to prioritizing the considered factors in selecting beverages, a Friedman test, which is used for analyzing overlapping responses, was adopted to check whether there were any significant differences among the criteria.

Results

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1. General characteristics of survey participants

The total number of survey participants was 349: 190 girls (54.4%) and 159 boys (45.6%). In terms of grade, 2nd grade students' represented the majority (130 students, 37.3%), followed by 1st grade students (118 students, 33.8%), and 3rd grade students (101 students, 28.9%).

2. Classification based on the level of sugar-related nutrition knowledge

High school student's level of sugar-related nutrition knowledge was assessed with a 15 questions; the full score was 15 points with 1 point for each correct answer and 0 points for incorrect answers. The result showed that the lowest score sugar-related nutrition knowledge was 3 point sand highest was 15 points, with an average score of 10.46. In order to divide the respondents based on the level of sugar-related nutrition knowledge, the average score was used as a benchmark. 151 students (43.3%) who scored lower than the average score (points between 3 and

10) were classified as the low knowledge group, and 198 students (56.7%) who scored higher than the average score (points between 11 and 15) were classified as the high knowledge group. Based on this classification, the present study conducted a comparative analysis on how the difference in the level of sugar-related nutrition knowledge affects sugary food in take behaviors, the status of consuming sugary processed foods, and the experience and interest in sugar-related education.

The contents of the questionnaire and the results of the survey on sugar-related nutrition knowledge levels are shown in Table 1. The total score of each topic is as follows.

The level of knowledge in "concept and characteristics of sugar" was 2.75 points/4 points in the high knowledge group and 1.99 points/4 points in the low knowledge group (p < 0.001). On the other hand, the level of knowledge in "sugar and food" was 3.11 points/4 points in the high knowledge group and 2.19 points/4 points in the low knowledge group (p < 0.001). The level of knowledge in "sugar and health" was 3.66 points/4 points in the high knowledge group and 2.71 points/4 points in the low knowledge group (p < 0.001); the level of knowledge in "sugar reduction" was 2.40 points/3 points in the high knowledge group, and 1.68 points/3 points in the low

Table 1. Analysis of nutrition knowledge in proportion to sugar-related nutrition knowledge

		Nutrition knowledge		χ^2 or t value (p-value)
		Low group (n=151)	High group (n=198)	
Topic				
Concept and characteristics of sugar		1.99 ± 0.93[1]	2.75 ± 0.78	−8.146 (< 0.000)***
Sugar and food		2.19 ± 0.90	3.11 ± 0.70	10.751 (< 0.000)***
Sugar and health		2.71 ± 1.00	3.66 ± 0.52	11.448 (< 0.000)***
Importance of sugar reduction		1.68 ± 0.81	2.40 ± 0.64	−9.335 (< 0.000)***
Statements on concept and characteristics of sugar				
1	Sugar is a small granule that tastes sweet when it is dissolved in water.	98 (64.9)[2]	181 (91.4)	37.558 (< 0.000)***
2	Sugar gives 9 kcal of energy per 1 gram.	98 (64.9)	77 (38.9)	23.186 (< 0.000)***
3	Glucose is a form of sugar that circulates in the blood.	109 (72.2)	179 (90.4)	19.714 (< 0.000)***
4	Brain uses only glucose as energy source.	40 (26.5)	64 (32.3)	1.393 (0.238)
Statements on sugar and food				
5	Sugar in natural foods is digested and absorbed faster than sugar in processed foods.	120 (79.5)	124 (62.6)	11.555 (< 0.001)**
6	There is sugar in milk.	90 (59.6)	164 (82.8)	23.326 (< 0.000)***
7	Natural foods such as fruits, honey, sweet potato, and sweet pumpkin contain sugar.	122 (80.8)	197 (99.5)	38.129 (< 0.000)***
8	Sugar-free juice does not contain sugar.	64 (42.4)	17 (8.6)	54.908 (< 0.000)***
Statements on sugar and health				
9	Cavities in teeth are caused by sticky foods such as caramel rather than by regular sugar consumption.	99 (65.6)	173 (87.4)	23.700 (< 0.000)***
10	Excess sugar turns into fat and accumulates in the body.	110 (72.8)	186 (93.9)	29.589 (< 0.000)***
11	Diabetic patients must not consume any sugar.	64 (42.4)	21 (10.6)	46.957 (< 0.000)***
12	Excessive sugar intake can cause diseases such as diabetes and cardiovascular diseases.	113 (74.8)	188 (94.9)	29.221 (< 0.000)***
Statements on importance of sugar reduction				
13	The World Health Organization recommends people reduce their daily sugar intake to less than 10% of their total energy intake.	87 (57.6)	173 (87.4)	39.931 (< 0.000)***
14	Korea does not have restrictions on the selling and advertising of "high-calorie and low-nutrition foods" to prevent excessive sugar intake.	100 (66.2)	77 (38.9)	25.612 (< 0.000)***
15	Nutrition facts must include sugar content.	115 (76.2)	181 (91.4)	15.479 (< 0.000)***

1) Mean ± SD
2) N (%)
**: p < 0.01, ***: p < 0.001

knowledge group (p < 0.001). In all topics, the group with higher knowledge in sugar-related nutrition manifested significantly higher nutrition knowledge than the lower knowledge group. In other words, the higher knowledge level the group had, the better the awareness level and the degree of understanding they had in all four topics.

Detail questions and their correct answer rates were looked into for each topic. The high knowledge group marked 91.4% and 90.4% correctly for *statement 1* and *3*, respectively, showing a significant difference from the low knowledge group's percentage of correct answers (p < 0.001). In contrast, for *statement 2*, the low knowledge group's percentage of correct answers (64.9%) was significantly higher than the high knowledge group's percentage of correct answers (38.9%) (p < 0.001). For statement 4, the both group showed a relatively low percentage of correct answers (32.3%) compared to other question items and did not display a significant difference.

In the topic related to sugar and food, the high knowledge group marked 82.8% and 99.5% correctly for each of *statement 6* and *7*, respectively, displaying a significantly higher percentage of correct answers than the low knowledge group's percentage of correct answers (59.6%, 80.8%) (p < 0.001). In the topic of sugar and health, all question items except for statement 11, the high knowledge group's percentage of correct answers was significantly higher than the low knowledge group's percentage of correct answers (p < 0.001). In the topic related to importance of sugar reduction, the high knowledge group's percentage of correct answers regarding *statement 13* and *15* were significantly higher than that of the low knowledge group (p < 0.001). However, with regard to the contents on restricting the sales and advertisement of high calorie and low nutrition foods to prevent over-consumption of sugars (*statement 14*), the low knowledge group had a significantly higher percentage of correct answers than the high knowledge group (p < 0.001).

3. Sugar intake behaviors based on the level of sugar-related nutrition knowledge

The result of analyzing the sugar intake behaviors based on the high school student's level of sugar-related nutrition knowledge is shown in Table 2. Mean values of the high knowledge group had generally desirable sugar intake behavior comparing to the low knowledge group. Among the 7 questions, the high knowledge group only showed a significantly more desirable behavior than the low knowledge group in *statement 2, 5, 6* and *7* (p < 0.05). In the other four statements (such as sugary food preference, eating sugary foods every day, trying to eat less sugary foods, eating bread with jam or cream cheese), the high knowledge group did not show a significant difference from the low knowledge group. However, the result indicates that the high knowledge group seeks a relatively desirable dietary behavior related to sugar intake compared to the low knowledge group.

Table 2. Sugar intake behaviors based on the level of sugar-related nutrition knowledge

Sugar intake behavior[1]	Nutrition knowledge		*t*-value (p-value)
	Low group (n=151)	High group (n=198)	
1 I eat sugary foods on a daily basis.	3.17 ± 1.04[2]	3.09 ± 1.00	0.674 (0.501)
2 When selecting foods, I usually check the sugar-related nutrition facts on the wrapper before buying them.	2.36 ± 1.10	2.98 ± 1.17	−2.371 (0.037)*
3 To reduce sugar intake, I try not to eat sugary foods.	2.74 ± 0.99	2.85 ± 0.99	−1.044 (0.297)
4 When eating bread, I put jam or cream cheese on it.	3.05 ± 1.17	2.90 ± 1.20	1.114 (0.266)
5 Instead of drinking regular milk, I frequently drink flavored milk (banana flavored, chocolate milk, etc.).	3.25 ± 1.33	2.77 ± 1.32	2.264 (0.047)*
6 I frequently drink soda instead of water.	2.66 ± 1.28	2.31 ± 1.22	2.372 (0.032)*
7 I frequently drink fruit juices instead of eating fresh fruits.	2.76 ± 1.19	2.48 ± 1.08	2.247 (0.025)*

1) Descriptor: 1: strongly disagree ~ 5: strongly agree
2) Mean ± SD
*: p < 0.05

4. Status of sugary processed food intake based on the level of sugar-related nutrition knowledge

In previous studies, adolescents' sugar intake was higher than those of any other age group; the sugar intake through beverages was the highest, and the main sources of sugar intake included baked goods, fast foods, and snack foods [3, 8, 16]. Hence, based on the previous study findings, the present study analyzed the consumption of food groups based on the level of sugar-related nutrition knowledge (Table 3). The result of analyzing the consumption of sugary food groups such as snack foods, baked goods, and beverages, the group with low knowledge in sugar-related nutrition was found to consume the food group more frequently; in particular, the frequency of consuming beverages was 5.01, which was significantly higher than that of the high knowledge group (4.10) ($p < 0.05$).

As a next step, we examined the consumption of typical food types in each food group (Table 4). Confectionary, biscuits, cookies and sugary cereals were less consumed in the high knowledge group. With regard to bakery goods, the two groups had no difference in the frequency of consuming bread; however, the high knowledge group had a tendency of low frequency in consumption of sweet bean paste, creamy baked goods and muffin cakes.

With regard to beverages, sports (ion) drinks was found to be consumed significantly more frequently in the low knowledge group (1.10 times) than in the high knowledge group (0.73 times) ($p < 0.05$) (Table 3). Apart from this, soda, fruit juices, flavored drinks, and energy drinks were tendency to be consumed less frequently in the high knowledge group. With regard to extract drinks and energy drinks, there were no difference between the two groups.

5. Experience and desire to participate in education based on the level of sugar-related nutrition knowledge

The result of surveying the awareness of sugar contents in drinks with rather high sugar content showed that 89.4% of the high knowledge group knew the sugar content of the drinks, whereas 81.5% of the low knowledge group did, which showed a significant difference in the level of awareness ($p < 0.05$) (Table 4). With regard to the need for relevant education in relation to this, the high knowledge group (77.3%) was significantly more aware of the need for educating students about the sugar content in the drinks han was the low knowledge group (64.2%) ($p < 0.01$) (Table 4).

With regard to the experience in learning about sugar based on the level of sugar-related nutrition knowledge,

Table 3. Type of sugary processed food intake based on the level of sugar-related nutrition knowledge

		Nutrition knowledge		t-value (p-value)
		Low group (n=151)	High group (n=198)	
Food group				
	Confectionary	3.12 ± 2.93[1]	2.94 ± 2.28	0.645 (0.519)
	Bakery goods	2.22 ± 2.35	1.97 ± 2.14	1.017 (0.310)
	Beverages	5.01 ± 4.03	4.10 ± 3.74	2.145 (0.033)*
Food type				
Confectionary	Biscuits	0.86 ± 1.22	0.84 ± 1.25	0.169 (0.866)
	Cookies	1.60 ± 1.25	1.54 ± 1.36	0.419 (0.672)
	Sweet cereals	0.72 ± 1.23	0.51 ± 0.96	1.851 (0.065)
Bakery goods	Bread	0.88 ± 1.17	0.88 ± 1.20	0.016 (0.987)
	Sweet pastry (with sweet bean paste or cream filling)	0.62 ± 0.98	0.55 ± 0.88	0.761 (0.447)
	Muffins, cakes	0.72 ± 1.15	0.55 ± 0.89	1.556 (0.121)
Beverages	Soda	1.92 ± 1.77	1.63 ± 1.77	1.537 (0.125)
	Fruit juices, fruit flavored drinks	1.30 ± 1.43	1.06 ± 1.33	1.583 (0.114)
	Sports (ion) drinks	1.10 ± 1.43	0.73 ± 1.34	2.437 (0.015)*
	Extract drinks (sweet rice drinks, cinnamon punch, Morning Rice, etc.)	0.48 ± 0.93	0.48 ± 1.09	−0.074 (0.941)
	Energy drinks (Hot Six, Red Bull, etc.)	0.21 ± 0.66	0.20 ± 0.67	0.209 (0.835)

1) Descriptor: intake number/week
*: $p < 0.05$

Table 4. Experience and interest in learning sugar-related topics, preferred learning methods, and learning contents based on the level of sugar-related nutrition knowledge

		Nutrition knowledge		Total	χ^2 (p-value)
		Low group (n=151)	High group (n=198)		
Awareness of sugar content in drinks	Yes	123 (81.5)[1]	177 (89.4)	300 (86.0)	4.473 (0.034)*
	No	28 (18.5)	21 (10.6)	49 (14.0)	
Need for educating on the sugar content in drinks	Yes	97 (64.2)	153 (77.3)	250 (71.6)	7.163 (0.007)**
	No	54 (35.8)	45 (22.7)	99 (28.4)	
Experience in learning sugar-related topics	Yes	17 (11.3)	39 (19.7)	56 (16.0)	4.529 (0.033)*
	No	134 (88.7)	159 (80.3)	293 (84.0)	
Interest in learning sugar-related topics	Yes	55 (36.4)	87 (43.9)	142 (40.7)	2.005 (0.157)
	No	96 (63.6)	111 (56.1)	207 (59.3)	
Method of learning sugar-related topics	Nutrition class at school	60 (39.7)	74 (37.4)	134 (38.4)	6.229 (0.178)
	School newsletter	49 (32.5)	49 (24.7)	98 (28.1)	
	Sugar reduction events	25 (16.6)	53 (26.8)	78 (22.3)	
	Text messages	10 (6.6)	15 (7.6)	25 (7.2)	
	Other	7 (4.6)	7 (3.5)	14 (4.0)	
Content of sugar-related topics	Nutrition facts of sugar (definition, types, pros & cons)	28 (18.5)	27 (13.6)	55 (15.8)	2.403 (0.493)
	Foods that contain too much sugar	45 (29.8)	62 (31.3)	107 (30.7)	
	Relationship between sugar and health	51 (33.8)	64 (32.3)	115 (33.0)	
	How to reduce sugar intake	27 (17.9)	45 (22.7)	72 (20.6)	

1) N (%)
*: $p < 0.05$, **: $p < 0.01$

19.7% of the high knowledge group and 11.3% of the low knowledge group responded that they "have been taught about sugar at school or other organizations" ($p < 0.05$) (Table 4). While 43.9% of the high knowledge group responded that they are "interested in participating in sugar education if classes are available," 36.4% of the low knowledge group expressed the desire to participate (Table 4), which showed that the high nutrition knowledge group was more keenly aware of the necessity of sugar-related education than the low knowledge group.

With regard to the preferred form of education based on the level of sugar-related nutrition knowledge, both groups mentioned "nutrition class at school" as the most appropriate way for conducting sugar-reduction education, followed by "sugar reduction events" for high knowledge group, and "school newsletter" for low knowledge group (Table 4). The demand for lessons on "relationship between sugar and health" and "foods that contain too much sugar" was over 30% of all responses. Additionally, "how to reduce sugar intake" made up 20.6% and "nutrition facts of sugar" 15.8%.

Discussion

The present study was conducted in order to provide baseline data for presenting a guideline for sugar reduction policy and education by examining current high school students' level of nutrition knowledge related to sugar and their status of sugar intake based on the knowledge levels.

The result shows a positive association between the knowledge level of sugar and the appropriate sugar intake behavior and sugary food choice. It was found that the high knowledge group displayed significantly high levels of awareness in all topics including "concept and characteristics of sugar," "sugar and food," "sugar and health," and "sugar reduction".

When examining the specific contents of questions in four topics, the rate of correct answers of both groups were below 50% with regard to the following contents: glucose as energy source, diabetes and sugar, sugar contained in processed beverages and digestion of sugar. Such results imply that high school students have simple knowledge

about sugar, but the accuracy of their knowledge is questionable. Considering that right actions can be drawn only when the knowledge is accurate, the need for education on the insufficient sugar knowledge is at stake. Results of the study on the development of a sugar education program for elementary school students conducted by Han & Lee [19] show that continuous in-school education about sugar in detail not only increases students' knowledge on sugar, but also brought positive changes in their eating habits. Therefore, it is believed that detailed education should be conducted and planned focusing on the lesser-known topics about sugar, and planned and long-term eating habits program should be developed in order to promote high school students' proper sugar intake.

With regard to high school students' sugar intake behaviors based on the level of sugar-related nutrition knowledge, the results show that the high knowledge group tries a relatively desirable behavior related to sugar intake compared to the low knowledge group, regardless of significance. Results of this study were similar to those of Yoo & Jung's stating [20] that the higher middle school students' nutrition knowledge score was, the lower their sugar intake frequency, sugar-related preferences, sugar-related eating behavior scores were. Other studies indicate that knowledge levels of specific foods or nutrition are related to eating behavior; nutritional knowledge levels and degrees of prevention practices regarding high blood pressure were positively correlated [21], a fixed positive correlation existed between housewives' nutritional knowledge and practice [22]. This study revealed similar results to those of previous studies, and such results indicate that the less sugar-related nutritional knowledge is, the more lack of interest in nutritional education exists and leads to a negative effect on sugar-related eating behavior [23, 24]. Since nutritional knowledge affects eating behavior, inaccurate knowledge can lead to incorrect eating behavior [24]. Whether nutrition knowledge affects eating behavior is still controversial. However when considering the result of this study as well past studies which revealed the relationship between nutrition knowledge and eating behavior, it could be said that students who have more sugar-related nutrition knowledge, were tendency to show a desirable eating behaviors such as reducing sugar intake

and paying careful attention to the selection of processed foods and beverages. Therefore, the cultivation of correct nutrition knowledge about sugar could be an important factor in having a healthy diet for high school students. As a result, proper eating behavior based on accurate knowledge should be encouraged to students by providing education on correct information that reflects possible adolescence nutritional health problems that can occur from sugar intake.

When examining the status of consuming the food groups that lead to too much sugar intake, the main sources were beverages, confectionary, and bakery goods in the corresponding order, irrespective of the level of nutrition knowledge related to sugar. In particular, the low nutrition knowledge group's frequency of consuming beverages was significantly higher than that of the high knowledge group ($p < 0.05$), as was the consumption of confectionary and bakery goods. According to the Korean Ministry of Food and Drug Safety [3], adolescents' daily average sugar intake (69.6g) is the highest of all age groups and 13% higher than Korean people's daily average sugar intake (61.4g). According to the survey result on the total sugar intake of adolescents (age 12~18) between 2008 and 2011, the most popular sugary foods for this age group were as follows: beverages (20.5%), fruits (15.7%), and baked goods · snack food · sweet rice cake (12.8%) in the corresponding order [3]. In other research, among the processed foods that children between 12 and 18 consume, the main sources of sugar intake were soda, snack food/ baked goods, and beverages [8]; this result was similar to Kim's study that reported favorite snacks among middle school and high school students were baked goods, fast foods, and snack foods in the corresponding order [16].

Based on the present research results, the frequency of sugar intake was highest with beverages in the sugary processed food group, and especially sports (ion) drinks was consumed more frequently by the low knowledge group than the high knowledge group. Also, although not statistically significant, the low knowledge groups showed a higher intake frequency of soda, fruit juice · fruit flavored drink. Such results are in line with other studies that claim sugar-sweetened drinks to be the main cause of adolescents'

sugar intake. According to Reedy et al, adolescents frequently consume sugar-sweetened drinks, and this is the main source of added sugar [25]. A study conducted in the United States by Wang and colleagues [26] also revealed that 84% of adolescents reported drinking more than one sugar-sweetened drink, and soda was the most frequently consumed one. Other previous studies asserted that much of the change in adolescents' added sugar intakes can be affected to changes in their beverage consumption patterns in other previous studies. As children progressed from childhood to early adolescence, both frequency and pre-valence of milk or fresh fruit juice intake decreased, while at the same time, soft drink consumption has escalated [27-29].

Several researchers have reported that hyperactivity and weak mental health as well as obesity, dental problem and type 2 diabetes were related to the consumption of soft drinks [30-34]. As types of sugar-sweetened drinks increase, recent studies show positive relationships between energy drink containing too much caffeine and sleeping disorder, between the increase in soft drinks intake frequency and increase in smoking or decline in grades [35-37]. Sugar intake through beverages is also considered as a serious problem in other countries; some European countries and Singapore implement various sugar reduction policies such as soda or sugar taxation against beverage manufacturing companies in an attempt to improve beverage components [38, 39].

KFDA (Korea Food and Drug Administration) [40] has announced a sugar reduction policy including processed food nutrition labeling regulations, support for sugar-reduced recipes development, and restrictions of selling high sugar foods targeting children in 2016 in an aim to lower sugar intake by processed foods to under 10%. Such implements of nationwide strategies and citizens' individual awareness and appetites improvement should be reached together. Appropriate sugar intake guidelines for adolescents are especially in need, because adolescents need more energy than other age groups but have less interest regarding health issues and thus have less negative awareness levels regarding sugar intake [41]. Therefore, various ways to encourage choosing healthful activities and drinks such as milk and water should be prepared, along with efforts to reduce adolescents' sugar-sweetened drink intake. Results of this study especially point out that many students (77.3% of the high knowledge group, 64.2% of the low knowledge group) felt the need for learning about the sugar content in drink, regardless of their nutrition knowledge levels. This indicates that high school students were sensitive to the need for learning about the sugar content in drinks. Therefore, high school students should have continuing nutrition education so that they can become aware of and consume healthful drinks.

Do and colleagues [42] reported that high school students in Gyeonggi province used taste (76.7%) and price (10.5%) as criteria in selecting drinks. That is to say, regardless of age, everyone considered "taste" to be most important when selecting drinks. Based on this, it appears that school cafeteria and homes need to identify the favorite taste among students and develop many recipes using natural ingredients instead of processed foods. With regard to drinks, although it is unfeasible to make and offer healthy drinks with reduced sugar content, it is necessary to provide continuing education to encourage students to select and consume healthy drinks at school where they spend most of their time, because healthy drinks are essential for their health and nutritional status.

With regard to the interest in participating in education on sugar, 43.9% of the high knowledge group and 36.4% of the low knowledge group responded positively. Although the high knowledge group's desire to participate is higher than that of the low knowledge group, the percentages of interested students in both groups were lower than those of uninterested students. Considering the current high school students' life, voluntary participation in learning something outside their regular curriculum seems difficult. Nevertheless, education related to eating habits is a crucial agenda for development and health during adolescence; hence, it is necessary to remind them of the importance of reducing sugar and help them practice it in various ways. With regard to methods of learning sugar-related topics, students responded that it is most appropriate to learn from "nutrition class in school." Therefore, it appears that education methods should be developed in connection with school classes. With regard to the content of sugar-related education, both groups expressed the strongest interest in learning

about "foods that contain too much sugar" and "sugar and health: diseases caused by over-consumption of sugar." That is, students wanted to learn about the foods they actually eat and about the health risk factors of consuming certain foods. Therefore, it is believed that necessary education programs for sugar reduction besides the specific interest areas can take place in stages if education for proper sugar intake is performed starting with the topics that students are interested in.

Conclusion

The major findings of this study and suggestions for future research are presented as follows. First, the result of examining sugar-related nutrition knowledge by topic showed that the level of awareness of the "concept and characteristics of sugar" was low. Based on this result, it is believed that sugar-related nutrition education targeting high school students regarding the topic of "concept and characteristics of sugar," which is less known, should be conducted after specific information is taught on top of basic knowledge. Second, the group with higher levels of knowledge in sugar-related nutrition displayed desirable eating habits related to sugar intake. Therefore, it is necessary to become aware of the importance of continuing nutrition education among students and to conduct a consistent education inside and outside of schools. Third, the result of examining the status of sugar intake showed that sugar intake through beverages was the highest, followed by snack foods and baked goods. Thus, for the drinks at school cafeterias or homes, natural ingredients should be utilized as much as possible in making beverages while considering student preference. Fourth, the group with higher levels of knowledge in sugar had more experience in learning about sugar and had a stronger desire to participate in educational programs related to sugar. In short, high schools should also offer nutrition classes as a part of the regular curriculum as in elementary and middle schools, and provide more educational opportunities for students to participate through systematic education to reinforce positive eating habits and help them practice low-sugar diets in real life. Park et al. [43] encouraged a natural decrease in sugar

intake for students via school meals. Therefore, inducements to decrease sugar intake should be made in diversified methods. Finally, research and education on sugar reduction is insufficient whereas lowering sodium is well-advocated. Therefore, academia needs to make an effort to conduct continuous research on education methods, and advocate and educate the down cut of sugar intake. Doing so will help students use their accurate knowledge of sugar reduction in real life.

The limitation of this study is that the results do not reflect attributes of the entire high school population, for the research focused on humanities high school students in Seoul. Therefore, future researches should look into cities other than Seoul.

Another limitation is that although the intake frequency of sugary processed foods and related eating behaviors can be caused by various reasons, this study did not consider all possible factors. In other words, this study was conducted under the assumption that increasing nutritional knowledge level of specific food products can change students' related eating behaviors and attitudes, and was focused only on this. However, adolescents' sugar intake behavior can differ according to many reasons. Therefore, if future studies explore multilateral factors that influence sugar intake and their relative influence levels, it could help establish political and educational plans to reach desired sugar intake behavior.

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