

한국 성인의 설탕세와 구강건강 인식의 연관성에 관한 연구

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A Study on the Relationship between the Sugar Tax and Oral Health Perception in Korean Adults

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Objectives: Sugar consumption continues to increase worldwide, and excessive sugar intake negatively affects both oral and systemic health. Many countries are attempting to reduce these adverse effects by imposing sugar taxes on products containing sugar. Korea is also trying to reduce sugar consumption, but does not currently have a sugar tax. The aim of this study was to investigate and to provide basic data on the association between sugar taxes and oral health awareness in Korea.

Methods: Korean adults were surveyed to determine the relationship between their perception regarding introduction of a sugar tax and their perception of oral health and the association between their oral health knowledge and behavior, as well as to establish the subjects' knowledge of sugar taxes.

Results: Subjects with a high interest in oral health also had a high interest in sugar taxes and a positive perception regarding the introduction of a sugar tax. Most of the study subjects, regardless of age or academic background, were unaware of sugar taxes and had not received education or information about sugar taxes. Therefore, press releases on sugar taxes and active publicity are needed to promote public interest in this area.

Conclusions: People's awareness of sugar taxes should be increased, and campaigns should be actively implemented to reduce sugar consumption. In addition, since no national measures are currently in place regarding the introduction of a sugar tax, efforts will be needed to regulate market activities in the food industry and to regulate the price of sugar-rich products nationwide to reduce sugar consumption in Korea.

Keywords Awareness, Dental status, Necessity, Sugar, Tax

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I. Introduction

The consumption of sugar was very small, about 120 years ago, but since the modern era, sugar has been produced in large quantities. It consumption continues to increase due to population growth and income growth[1]. In particular, the consumption pattern of developing countries is changing with the increase in consumption of processed foods containing sugar such as dairy products[2]. As of 2011, the world's sugar consumption rose 2.7 percent year-on-year to 169.77 million

tons, while the country that consumes the most sugar consumed 26.5 million tons annually in India, followed by the EU with 17.8 million tons, China with 14.4 million tons, Brazil with 17.5 million tons and the United States with 10.44 million tons, with the five countries accounting for 49.5 percent of the total[3]. In a similar phenomenon, Koreans also ate 61.4 grams per serving as of 2010, up 23 percent from 49.9 grams in 2008[4]. According to recent statistics, for one year of average per rice 81.3 kg[5], sugar, as compared to consumption was reported that up to take 25.9 kg[1]. That's more than 30 percent

of the rice in sugar.

Excessive sugar intake can lead to nutritional imbalances and can lead to cardiovascular disease, cancer, diabetes and obesity[6]. The American ST. Luke's heart institute says that when sugar is ingested, blood pressure rises because osmotic pressure causes the blood vessels to become watery and not reduce their size. Sugar also has a negative effect on oral health[7]. One of the most common oral diseases caused by sugar intake is dental caries, which is caused by sugars and saliva bacteria making acid and damaging enamel surface[8]. Frequent intake of high-sugar, high-adhesion foods increases the risk of being transferred to tooth decay and the risk of tooth erosion. According to a study of elementary school students, the higher the frequency of intake of sugary snacks, the higher the number of dental caries[9]. In addition, patients with hypertension, hyperlipidemia, stroke, myocardial infarction and osteoporosis due to intakes of sugar showed a higher prevalence of dental disease compared to ordinary people[10]. These studies show that excessive consumption of sugar has a negative effect on oral health and systemic health.

Recently, in some countries, the government introduced a sugar tax as a policy to address health problems caused by increased sugar consumption around the world[9][11]. Sugar tax is a tax on sugar-rich products for the purpose of preventing various diseases such as obesity[11]. In the UK, the sugar tax policy was introduced because sugar adversely affects obesity and oral health[12]. Pennsylvania in the U.S. which has been enforcing sugar taxes since 2015, showed its consumption of soft drinks drop 40 percent compared to that of Michigan two months after its implementation, and Washington State also secured \$4 million in tax revenue over three months, which helped reduce obesity rates by using it in health programs[13]. In view of this fact, it is less than five years since the sugar tax was implemented, but it is evaluated as a policy necessary for positive outcomes such as reducing the prevalence of non-infectious diseases in many countries including the United States, the United Kingdom, and Mexico.

Korea began mandatory labeling of sugar content in 2007, but the public's interest is not high and the expected policy effect is not reported yet[14]. There is still a great academic

consensus that there is an urgent need for the introduction of sugar taxes in Korea, but there is no data on sugar press releases and surveys of public perceptions.

The purpose of this study is to investigate the relationship between the public's perception of the tax imposition and the oral health awareness, and to establish the opportunity for interest in the introduction of sugar tax. It is expected to prepare the basic data necessary for the introduction of sugar tax.

II. Materials and methods

1. Participants of the subjects

From March to April 2019, we selected adult men and women from 20 to over 50 years of age who live in Seoul, Gyeonggi-do, and Chungcheongnam-do. To calculate the sample size using G power 3.14 program, the survey required at least 150 people, assuming significance level, effect size, and statistical power of 0.05, 0.10, and 0.95, respectively. A total of 209 questionnaires were distributed, and 206 of them were subject to final analysis, except for the three surveys that were not fully answered and were not properly processed.

2. Survey method

This study used a self-controlling questionnaire, and the questionnaire developed by the preceding study[15-19] was modified and supplemented by the research team. The survey items consisted of general characteristics (5 items), oral health care awareness (2 items), oral health care knowledge (10 items), oral health care behavior (10 items), sugar tax recognition (9 items), knowledge of sugar (5 items), and sugar intake behavior (4 items). In the recognition of the introduction of sugar tax, all items used the Likert 5-point scale and reported 5 out of 5. The closer to 5, the higher the knowledge. The closer to 1, the lower the knowledge. This study was conducted IRB approval (00-201904-015-1).

3. Statistical analysis

The data in this study were analyzed using the SPSS 20.0 (IBM SPSS Statistics 20.0, IBM, Inc., Chicago, IL, USA) statistics program for analysis. The general characteristics were analyzed by frequency analysis. Knowledge of sugar intake, awareness of sugar tax introduction and behavior of sugar intake, oral health knowledge were used by cross analysis. Knowledge of oral health behaviors and sugar tax was analyzed using One-Way ANOVA Analysis. A significance level of statistical significance was tested below 0.05.

III. Results

1. General Characteristics of Subject

In the general characteristics of the subjects, the age of the 20's was the highest with 44.7%, the 30's to 40's was 32.5%, and the over 50's was 22.8%. 28.6% of high school graduates and 70.9% of those who graduated from university or graduate school. In the monthly income, the less than 3 million won was 27.2%, between 3 million and 5 million won was 41.3%, and the person with more than 500 won was 31.6%. In subjective health status, 'very bad' was 1.5%, 'bad' was 17.5%, 'moderate' was 44.7%, 'good' was 31.6% and 'very good' was 4.9%. In subjective oral health, 2.4% were very bad, 26.7% were bad, 49% were normal, 18.9% were healthy, and 2.9% were very healthy <Table 1>.

2. Awareness of Introduction of Sugar Tax according to the Age and Educational Level of the Study Subjects

Table 2 shows the perceptions of the introduction of sugar tax and the knowledge of sugar according to the age and education level of the study subjects. All items of perception of the introduction of sugar tax used the Likert 5-point scale. 5 out of 5, the closer to 5, the higher the knowledge, the closer to 1, the lower the knowledge. The question of whether or not they know sugar taxes averaged 2.24, regardless of

<Table 1> General Characteristics of Subject

Variable	N	%
General health		
Age		
20's	92	44.7
30-40's	67	32.5
More than ≤ 50's	47	22.8
Education level		
High school	59	28.6
University~Graduate school	146	70.9
Monthly income (10.000won)		
Less than 300	56	27.2
300-500	85	41.3
More than 500	65	31.6
Subjective health status		
Very bad	3	1.5
Bad	36	17.5
Normal	92	44.7
Good	65	31.6
Very good	10	4.9
General disease		
No got	164	79.6
Diabetes	5	2.4
High blood pressure	20	9.7
Cardiovascular disease	4	1.9
Kidney disease	1	0.5
The others	12	5.8
Oral health		
Oral health condition		
Very bad	5	2.4
Bad	55	26.7
Normal	101	49.0
Good	39	18.9
Very good	6	2.9
Observable symptoms		
Ache or pain	43	20.9
Mouth dryness	22	10.7
Bad breath	20	9.7
No got	108	52.4
The others	13	6.3

Values are presented as a number (%).

age and education, and found that the most subjects did not know about sugar taxes. The question of whether they had

<Table 2> Awareness of Introduction of Sugar Tax according to the Age and Educational Level of the Study Subjects

Categories	Age			p-value	Education level		p-value
	20's	30-40's	50's≤		≤High school	University≤	
Do you know about sugar tax?	2.26±1.10	2.01±1.05	2.43±1.22	0.133	2.38±1.18	2.15±1.09	0.168
Did you get sugar tax education or information?	1.66±0.71	1.71±0.73	1.86±0.85	0.417	1.77±0.69	1.70±0.78	0.526
Do you know any other country sugar tax?	1.64±0.79	1.71±0.86	1.86±0.83	0.313	1.88±0.85	1.65±0.81	0.071
Does sugar tax have reduced social cost effect?	2.51±0.96	2.62±1.09	2.69±1.15	0.589	2.72±0.99	2.53±1.07	0.231
Does sugar tax have health promotion effect?	2.61±1.08	2.64±1.12	2.97±1.22	0.183	2.94±1.13	2.60±1.12	0.052

Values are presented as a mean and standard deviation.
The total score is '5'.

been informed about education or information on sugar taxes also showed an average of 1.74 regardless of their age and educational background, and most of the study subjects had no education or information on sugar taxes. The question of whether the introduction of sugar taxes would reduce social costs averaged 2.61, regardless of age and educational background, and most respondents said that the reduction in social costs from the introduction of sugar taxes would be ineffective. The question of whether the introduction of sugar taxes will improve health has averaged 2.75, regardless of age and education. Most of the respondents said that the introduction of sugar tax would not improve health.

3. Awareness of Sugar Tax and Its Behavior of Sugar Consumption

Regarding the introduction of sugar tax and the behavior of sugar intake according to the age and education level of the study subjects, the results are shown in Table 3. In the question about whether they support the sugar tax, according to their age, 20s and 30s to 40s were 65.2% and 56.7%, respectively. Depending on their educational background, 'no' was high. In the question about the reason for opposing the sugar tax, the 20s were the highest due to 'the burden of the cost', 'they are not familiar with the sugar tax' at 17.4%, and the 30s to 40s were 'because it would not help to improve health'. The highest score was 22.4%, and this item showed a significant difference according to age ($p=0.031$). For those in their 50s and above, 'because of the high cost' was the highest at 24.4%, and depending on their educational background, 'because of the high cost' was high. If sugar taxes were introduced,

the question of how many percent would be appropriate was the highest in both ages and educational backgrounds. According to the question about whether there is a plan to reduce sugar intake when introducing the sugar tax, according to age, 20s and 30-40s were 37%, and 27.3%, respectively, and over 50s, 45.7% were high. According to the educational background, the average was 37.3%, and 35.9%. There were no significant differences in this question according to age and educational background ($p>0.05$) <Table 3>.

4. Knowledge of Sugar Import and Knowledge of Sugar and Association of Oral Health Awareness, Knowledge, and Behavior

There was a significant difference in the analysis of the association between the introduction of sugar tax and knowledge about sugar and oral health awareness, knowledge and behavior <Table 4>. Those with high oral health knowledge had a higher average knowledge than those with low oral health knowledge with 3.55 knowledge of sugar and 11.64 perception of introducing sugar tax. Those with good oral health behavior had a higher average than those with poor oral health behavior with 3.47 knowledge of sugar and 12.03 perception of introducing sugar tax. There was no significant difference between the subjects' perception of the introduction of sugar tax and the average knowledge of sugar and oral health awareness ($p = 0.778$, $p = 0.474$).

<Table 3> Awareness of Sugar Tax and Its Behavior of Sugar Consumption

Categories	Age						P-value	Education level				P-value
	20's		30-40's		50's≤			≤High school		University≤		
Do you agree to the Sugar tax?												
Yes	32	34.80	29	43.30	25	55.60	0.067	26	44.10	60	41.40	0.724
No	60	65.20	38	56.70	20	44.40		33	55.90	85	58.60	
What is the reason for opposing sugar?												
Cost burden	16	17.40	10	14.90	11	24.40	0.426	12	20.30	25	17.20	0.603
Not help health promotion	13	14.10	15	22.40	2	4.40	0.031	11	18.60	19	13.10	0.311
Do not know sugar tax	16	17.40	8	11.90	3	6.70	0.205	5	8.50	22	15.20	0.201
Do not need sugar tax	14	15.20	9	13.40	5	11.10	0.804	6	10.20	22	15.20	0.346
Other reasons	5	5.40	2	3.00	0	0.00	0.252	2	3.40	5	3.40	0.983
If you charge a sugar tax, what percentage is appropriate?												
Not at all	46	50.00	32	48.50	20	44.40		28	47.50	70	48.60	
Less than 5%	32	34.80	23	34.80	12	26.70		22	37.30	45	31.20	
Less than 5 - 10%	8	8.70	7	10.60	10	22.20	0.658	6	10.20	19	13.20	0.421
Less than 10 - 15%	3	3.30	2	3.00	1	2.20		0	0.00	6	4.20	
15% or more	3	3.30	2	3.00	2	4.40		3	5.10	4	2.80	
What is the main disease caused by sugar intake?												
Cavity	25	27.20	27	40.30	17	37.80		23	39.00	46	31.70	
Obesity	22	23.90	23	34.30	10	22.20		15	25.40	40	27.60	
Diabetes	41	44.60	15	22.40	13	28.90	0.05	17	28.80	52	35.90	0.73
High blood pressure	2	2.20	1	1.50	1	2.20		1	1.70	3	2.10	
Cardiovascular disease	2	2.20	1	1.50	4	8.90		3	5.10	4	2.80	
How many snacks do you take a week?												
0 to 1 times	15	16.30	11	16.40	17	37.00		16	27.10	27	18.60	
2 to 3 times	39	42.40	31	46.30	14	30.40	0.038	21	35.60	63	43.40	0.161
4 to 5 times	14	15.20	17	25.40	8	17.40		15	25.40	23	15.90	
more than 5 times	23	25.00	8	11.90	7	15.20		7	11.90	31	21.40	
What type of food do you eat that contains sugar?												
Snacks	21	22.80	26	38.80	11	23.90	0.066	15	25.40	42	29.00	0.609
Candy and jelly	14	15.20	4	6.00	5	10.90	0.147	7	11.90	16	11.00	0.285
Chocolate	15	16.30	9	13.40	4	8.70	0.47	4	6.80	24	16.60	0.066
Bread and cakes	10	10.90	22	32.80	14	30.40	0.004	23	39.00	23	15.90	0.001
Beverage	32	34.80	10	14.90	16	34.80	0.012	13	22.00	45	31.00	0.196
Ice cream	9	9.80	1	1.50	2	4.30	0.079	1	1.70	11	7.60	0.105
The other	0	0.00	1	1.50	0	0.00	0.355	0	0.00	1	0.70	0.523
Why do you eat foods that contain sugar?												
Hungry	8	8.80	5	7.50	3	6.50	0.888	3	(5.10)	13	9.00	0.344
Delicious	53	58.20	43	64.20	19	41.30	0.109	33	(55.90)	82	56.90	0.805
Sugar was the essential nutrient	0	0.00	2	3.00	1	2.20	0.276	3	(5.10)	0	0.00	0.006
Stress relief	17	18.70	7	10.40	7	15.20	0.241	8	(13.60)	22	15.30	0.77
Habit	7	7.70	8	11.90	15	32.60	0.001	12	(20.30)	18	12.50	0.301
The other	7	7.70	1	1.50	1	2.20	0.121	2	(3.40)	7	4.90	0.644
Do you have any plans to reduce your sugar intake if the sugar tax is introduced?												
Not quite	15	(16.30)	8	(11.90)	2	(4.30)		6	(10.20)	19	13.10	
No	24	(26.10)	17	(25.40)	7	(15.20)	0.071	9	(15.30)	39	26.90	0.231
Be average	34	(37.00)	25	(37.30)	15	(32.60)		22	(37.30)	52	35.90	
Right	17	(18.50)	16	(23.90)	21	(45.70)		20	(33.90)	33	22.80	
Be quite so	2	(2.20)	1	(1.50)	1	(2.20)		2	(3.40)	2	1.40	

Values are presented as a number (%).

The data were analyzed by One-Way ANOVA.

<Table 4> Knowledge of Sugar Import and Knowledge of Sugar and Association of Oral Health Awareness, Knowledge, and Behavior

	Awareness of oral health		Knowledge of oral health		Behavior of oral health	
	Low	High	Low	High	Low	High
Knowledge of sugar	3.02±1.42	3.22±1.48	2.84±1.50	3.55±1.32	2.88±1.51	3.47±1.34
p-value	0.474		0.010		0.026	
Awareness of sugar tax	10.85±3.14	11.00±3.59	10.40±3.40	11.64±3.41	9.98±3.12	12.03±3.50
p-value	0.778		0.010		<0.001	

Values as presented as a mean and standard deviation.

Total score of knowledge of sugar: 5.

Total score of awareness of sugar tax: 25.

IV. Discussion

Sugar intake continues to increase worldwide, causing a number of health problems. Excessive sugar intake can lead to nutritional imbalances and can lead to cardiovascular disease, cancer, diabetes, obesity[6], and negatively affect oral health[7]. In recent years, the introduction of sugar tax has been introduced worldwide to reduce such chronic diseases[9][11], but in Korea, only voice urgently recommends the introduction of sugar tax. Therefore, the purpose of this study is to investigate and analyze the people's perception of sugar tax and its association with oral health awareness in order to introduce a sugar tax on sugar-containing products to reduce sugar consumption.

When asked if they knew about sugar taxes or if they had ever received education or information on sugar taxes, most of the study subjects, regardless of age or academic background, responded that they did not. Lee et al.[20] study, which mainly found information on reduction of sugar intake through 'internet' and 'TV', is thought to require press releases and active promotion of sugar taxes to promote the publics.

The cost of disease, treatment, and prevention due to excessive consumption of sugar is staggering around the world[21]. When asked if the introduction of a sugar tax would likely reduce social costs, most of the subjects responded that there would be no social cost reduction. Also, when asked if it would be effective in improving health, most of them answered that the introduction of a sugar tax would not have an effect on their health. However, looking at current trends in countries that have introduced sugar tax, it is expected to bring positive results in many ways. According to the nation's latest statistics, a

whopping 25.9 kg of sugar is reported, compared to an average of 81.3 kg of rice per person per year. Foods, snacks, and beverages containing sugar are readily available on the market, and the amount of sugar consumed is on the rise. On the other hand, when asked whether they planned to reduce sugar intake in the introduction of the sugar tax, 45.7 percent of those in their 50s and 40s answered "yes," while 37 percent and 23.7 percent of those in their 20s and 40s answered "normal." It was similar to Kim et al.'s study[17] that people in their 50s and 60s had a more active attitude than those in their 20s and 40s to try to reduce sugars when eating out.

In the question of whether to approve the sugar tax, those in their 20s and 30s to 40s had 65.2 % and 56.7%, while those in their 50s or older had 55.6 %. Kim et al.[21] can confirm the positive facts about sugar tax introduction and reduction in sugars in people in their 50s and older, as in the study, in which people in their 50s and 60s preferred the direction of reducing sugar for sugars. In the question of the reasons for opposing the sugar tax, the highest ratio was 17.4 percent for those in their 20s and 40s, and 22.4 percent for those in their 30s and 40s because they thought they would not be able to help improve their health, with significant differences depending on their age. In a study on tobacco taxes conducted by Lee et al. [22], 46.2 percent of university students said they were willing to quit smoking if prices went up. As such, people in their 20s have a negative reaction to cigarette taxes and sugar taxes due to their high cost. If a sugar tax is introduced, all of the questions about how much is appropriate were 'not willing to pay at all'. Comparing to the study by Lee et al. [22][23][24], if cigarette prices are raised to 6,000

won, it can be confirmed that unlike the study, which found that all smokers are willing to quit smoking, they are very negative about raising sugar prices.

Analysis of the association between oral health knowledge and oral health behavior in the perception of introducing sugar tax and knowledge of sugar tax, found that oral health knowledge and oral health behavior of the study subjects were correlated. People with high oral health knowledge or behavior were found to have significantly higher knowledge of sugar and awareness of the introduction of sugar taxes compared to people with low oral health knowledge or behavior. On average, people who are interested in oral health as well as general health are highly likely to have some knowledge or awareness of sugar consumption, which can affect body and oral health. In other words, the more people are interested in oral health, the more interested they are in sugar taxes.

The limitation of this study is that it is difficult to generalize it as a result that represents the whole adult in Korea, since the survey area is limited to Seoul, Gyeonggi, and Chungnam. Dividing the study subjects into various age groups, it was difficult to conduct the survey, and the researcher could not proceed with the question by explaining the gender ratio by dividing male and female genders. In the future, researchers should explain the survey so that they can get a qualitatively high response. Despite these limitations, it is thought that this study is meaningful that oral health knowledge and behavior have found a significant link between knowledge of sugar and awareness of sugar tax introduction, and has identified differences in perceptions of sugar tax by age and academic background.

In conclusion, we should raise the public's awareness of the sugar tax. Campaigns to raise public awareness of sugar taxes and educate people to drink water instead of sugary drinks should be actively carried out by inserting and selling statements warning of the dangers of sugar-containing diseases in products with high sugar content. Also, since there are currently no national measures in place regarding sugar taxes at home, efforts will be needed to regulate market activities in the food industry and to regulate the price of sugar-rich products nationwide to reduce people's sugar consumption.

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