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Original Article

Changes in Dietary Behavior Among Adolescents and Their Association With Government Nutrition Policies in Korea, 2005-2009

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Objectives: This study was conducted to observe recent changes in adolescents' dietary behavior and indirectly evaluate the effects of the government's nutritional policies in Korea.
Methods: We analyzed the secular trends in seven dietary behaviors using the Korea Youth Risk Behavior Web-based Survey data from 2005 to 2009. Through literature review, we included the policies implemented for the improvement of adolescents' dietary behaviors during the same periods.
Results: The significant linear trends were observed in all dietary behaviors ($p<0.05$). Overall, all behaviors except the fruit intake rate were desirably changed during five years but undesirable changes were observed between 2008 and 2009 in all behaviors. Within those periods, several policies were implemented including 'Ban on carbonated-beverages in school', 'Green Food Zone', etc. Despite confirmed evidence of their effects, the policies on individual behavior such as nutrition education didn't influence the prevalence of dietary behaviors because they were conducted to too limited persons. Polices on the school environmental improvement, such as ban on carbonated beverage in school, were more effective because they decreased the exposure of undesirable food environment. However, for effect of Green Food Zone improving community environment we couldn't come to a conclusion because of too short period after full implementation.
Conclusions: Among government nutrition policies conducted from 2005 to 2009, those on environmental improvement, especially in school, were more effective than those on individual behavior. Therefore, the development and implement of policies on school environmental improvement are needed in Korea.

Key words: Adolescent, Food habits, Policy, Trends
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INTRODUCTION

Adolescence is a period when nutrition demand increases due to rapid growth and active physical activities, and adequate nutrition supply through desirable dietary behavior is absolutely necessary. However, inappropriate dietary behavior can induce obesity, which can have negative effects on physical and psychological development [1]. In this transitional mental and physical development stage, not only do the dietary behaviors started at infancy become permanent, but it is also known to be a period when the adolescent acquires autonomy in terms of food selection [2,3]. If inappropriate dietary behavior is developed at this stage, it will continue until adulthood and, consequently, have a detrimental effect on health [2]. Thus, it is very important for adolescents to maintain desirable dietary behavior during this period. Family, school, and community take part in the development of dietary behavior; however, parents at home play an especially critical role [4]. Recently in Korea, occasions to consume instant food or eat at fast-food restaurants to eat out have increased, and the opportunities for children and adolescents to learn, and acquire, healthy dietary behavior through the family model have decreased [5]. Hence, it has become more important to develop, and carry out, policies that help adolescents to prepare themselves with desirable dietary behavior at the school, community, and government levels [5,6].

The approach to develop appropriate dietary behavior can be classified into directly inducing a change of behavior through nutrition education or nutrition counseling and creating an environment that supports appropriate dietary behavior [7]. Education is known to

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be the most effective way to improve one's dietary life [6,8], but it has some limitations in terms of cost-effectiveness [4,9]. On the other hand, there are reports that desirable changes in dietary behavior are expedited and maintained longer in a health-friendly environment, thus emphasizing the importance of a community-based approach to create a supportive environment [4,9]. Among various types of communities, improving the food environment in schools is suggested to be an especially effective approach at the community level, which not only enhances dietary behavior development but also decreases the risk of obesity [4,10].

The school is the place where adolescents spend the largest amount of time in a day, and where they eat at least one meal. Therefore, interventions to improve the food environment in school, such as limiting access to competitive foods can be easily coordinated and managed and have a broad impact on a student's food choice [10]. According to foreign studies, students who attended schools with no compliance to nutritional standards for lunch programs and with easy access to competitive foods were more prone to inappropriate dietary behavior, compared to students who attended other schools [11,12].

For this reason, the US Department of Agriculture set standards for nutrient contents of school meals [13], and the US Institute of Medicine strongly recommended that schools restrict the sale of competitive foods [14]. Aside from that, in order to improve the environment outside the school, various policies and strategies, such as restrictions of food advertisement, marking of ingredients of manufactured food, and a fat tax, have been implemented in some countries [4,5,8], and evidence concerning the effects of those policies has consistently been accumulated [7,8,10].

In the case of Korea, one of the main tasks of the Korean Health Plan 2010 (emanating from a white paper published in 2002 by the Ministry of Health and Welfare [MOHW] about health promotion in Korea) was the improvement and enhancement of student nutrition. Following these efforts, many policies have been implemented, such as the enhancement of nutrition in school meals, nutrition education, and the establishment of standards for the sale of food inside the school [15]. However, research on how these strategies and policies affect the dietary behavior of Korean adolescents was limited to nutrition education [16,17].

In general, it is known that randomized trials are the most valid method to assess a policy's effects. However, if the target population of public health policies is either a community or an entire country, randomized trials can logically be difficult to implement, not only because impact evaluations are costly and labor-intensive but also because of political conflicts between regions that stand to enjoy the benefits of the policies and regions that do not [18]. In this case, a method called interrupted time-series study (ITS), which compares data before and after particular interventions, using collected data from regular time intervals without any control groups, can be an adequate alternative to indirectly assess the effect of interventions [19]. Although rare, there have been some researches outside Korea to evaluate a policy's effect using ITS [20-22]. Some adolescent nutrition policies are promoted with all the adolescents as targets, and even with those adolescents who induce disputes, it is difficult to get data that can distinguish between them. However, it is able to assess the particular policy's effect indirectly by comparing adolescents' dietary behavior before and after implementation.

This study was conducted to observe recent changes in adolescents' dietary behavior and indirectly evaluate the effects of the government's nutritional policies on them using ITS methods in Korea.

METHODS

I. Subjects

This research, in order to observe secular trends of the primary dietary behavior of adolescents, used the Korea Youth Risk Behavior Web-based Survey (KYRBWS) original data of 2005-2009, and, through a literature review, selected related policies. Policies were included whose purposes were to improve adolescents' dietary behavior and were performed after 2005 by MOHW or the Ministry of Education, Science and Technology (MEST), or their affiliated organizations. Policies that stopped at the planning stage, or were performed after September 2009, (in 2009, 5th KYRBWS was started) were excluded from the analysis. Since 2005, KYRBWS has been performed every year by the Korean Center for Disease Control with the purpose of calculating representative and confidential public health index information related to the present condition of health behaviors of Korea's adolescents, as well as providing statistical data that can aid in the planning and assessment of adolescents' health promotion policies. In 2005 (the beginning year of investigation), the number of targeted subjects was 65 000 students from the 1st grade of middle school up to the 2nd grade of high school. In 2006, the number of students who participated

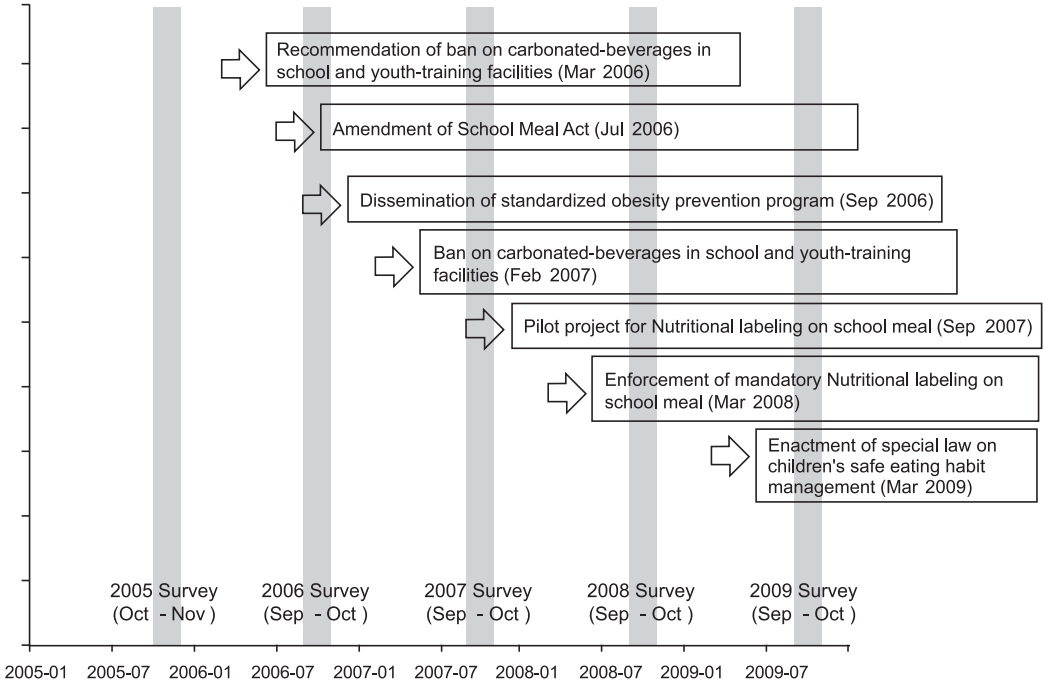

Figure 1. Government nutrition policies affecting adolescents' dietary behaviors.

was about 80 000 students every year from the 1st grade of middle school up to the 3rd grade of high school, and the participation rate ranged from 89.7% to 97.6%, depending on the year [23].

II. Variables

In order to observe the progress of the adolescents' dietary behavior, seven indices of dietary behavior in KYRBWS were analyzed. Among them, fruit, vegetable, and milk consumption were included in the "desirable eating behavior" category, and carbonated-beverage, fast-food, instant noodle, and confectionary consumption were included in the "undesirable eating behavior" category. Dietary behaviors, according to the index definition of KYRBWS, included fruit consumption more than once a day, vegetable consumption more than three times a day and milk consumption more than twice a day. The rest four indices, defined as the percentage of people who ingested applied food at least once a week [23].

III. Analysis

Frequencies and a 95% confidence interval of dietary behavior for each of 5 years, from 2005 to 2009, were suggested. To identify the amount of change, the difference between the 2005 and 2009 results and the difference between the maximum value and minimum value (fluctuation range) over the 5-year period were also suggested. The statistical significance between the two successive years was compared using a 95% confidence interval [24]. Logistic regression analyses for secular trend during the entire period were conducted, using each year as an explanatory variable and each dietary behavior index as a dependent variable. When performing the calculations, the primary function (linear trend) was preferentially assessed, and in case the fluctuation range was high in some indices but total amount of change over the 5 year period was small, the tendency of secondary function (quadratic trend) was analyzed to supplement the difficulty with primary function only. An appropriate yearly coefficient (-2, -1, 0, 1, 2) was used for the tendency of secondary function [25], and by incorporating school grade, gender, and residing region into the model as covariates, from the trend test related to the primary and secondary function, those effects were adjusted. In addition, in order to verify if there exists any difference in secular trends according to gender, region, type of school, and socioeconomic level, secular trends were respectively observed in each stratum after those variables had been stratified. Subjective economic status was used as a proxy index related to the socioeconomic level. The effects of particular policies were indirectly evaluated by comparing annual prevalence of dietary behavior before and after particular policies were carried out. All analysis was done through SAS version 9.2 (SAS Inc., Cary, NC, USA), and the statistical significance level was 0.05.

Table 1. Adolescents' fruits consumption rate changes from 2005 to 2009

	Annual prevalence of diet behaviors (95% CI)					Difference		Linear trends[1]		Secular trends[1]	
	2005	2006	2007	2008	2009	Diff1[2]	Diff2[3]	Crude	Adjusted	Crude	Adjusted
Total population	32.6 (31.8 - 33.5)	32.3 (31.5 - 33.0)	30.1 (29.3 - 30.8)*	34.6 (33.9 - 35.3)*	24.7 (24.1 - 25.4)*	-7.9	9.9	-0.065†	-0.051†	-0.047†	-0.056†
Gender[4]											
Male	32.0 (30.9 - 33.0)	31.0 (29.9 - 32.0)	29.3 (28.3 - 30.3)	33.2 (32.3 - 34.2)*	24.0 (23.3 - 24.8)*	-8.0	9.2	-0.067†	-0.051†	-0.043†	-0.052†
Female	33.4 (32.2 - 34.6)	33.8 (32.6 - 34.9)	31.0 (29.9 - 32.1)*	36.2 (35.2 - 37.2)*	25.5 (24.6 - 26.5)*	-7.9	10.7	-0.064†	-0.051†	-0.052†	-0.061†
School type[5]											
Middle	36.9 (35.9 - 38.0)	37.4 (36.5 - 38.4)	35.0 (34.0 - 36.0)*	39.9 (38.9 - 40.8)*	28.9 (27.9 - 29.9)*	-8.0	11.0	-0.060†	-0.060†	-0.049†	-0.050†
General high	27.8 (26.5 - 29.2)	28.7 (27.2 - 30.1)	27.1 (25.9 - 28.3)	31.5 (30.4 - 32.5)*	22.3 (21.5 - 23.1)*	-5.5	9.2	-0.050†	-0.050†	-0.062†	-0.067†
Vocational high	18.5 (17.2 - 19.8)	20.1 (18.6 - 21.5)	17.6 (16.2 - 19.0)	21.9 (20.8 - 23.0)*	15.1 (14.0 - 16.3)*	-3.4	6.8	-0.038†	-0.029†	-0.052†	-0.058†
Region[6]											
Large city	34.3 (33.4 - 35.3)	33.1 (32.1 - 34.1)	31.6 (30.7 - 32.6)	36.1 (35.3 - 36.9)*	25.6 (24.8 - 26.3)*	-8.7	10.5	-0.069†	-0.053†	-0.050†	-0.058†
Small city	31.7 (30.1 - 33.4)	32.6 (31.3 - 34.0)	29.3 (27.9 - 30.6)*	33.5 (32.2 - 34.8)*	24.1 (23.0 - 25.3)*	-7.6	9.4	-0.072†	-0.054†	-0.049†	-0.058†
Rural area	26.0 (24.2 - 27.8)	25.4 (23.7 - 27.1)	22.9 (21.6 - 24.2)	27.9 (26.3 - 29.5)*	20.6 (18.6 - 22.6)*	-5.4	7.3	-0.045†	-0.023	-0.017	-0.031†
Subjective economic status[5]											
Upper	38.7 (37.7 - 39.7)	47.5 (45.8 - 49.2)*	48.4 (46.5 - 50.3)	50.4 (48.7 - 52.2)	37.5 (35.5 - 39.5)*	-1.2	12.9	-0.074†	-0.051†	-0.062†	-0.070†
Middle	24.4 (23.6 - 25.3)	31.7 (31.0 - 32.5)*	29.5 (28.8 - 30.3)*	34.3 (33.7 - 35.0)*	24.5 (23.8 - 25.1)*	0.1	9.9	-0.060†	-0.048†	-0.048†	-0.056†
Lower	20.3 (18.5 - 22.1)	18.7 (17.2 - 20.1)	18.8 (17.4 - 20.3)	22.1 (20.7 - 23.5)*	16.2 (15.0 - 17.4)*	-4.1	5.9	-0.033†	-0.017	-0.033†	-0.045†

Fruits consumption: percentage of students who ate fruits one or more times per day during the past 7 days before survey.
CI, confidence interval.
[1]Coefficients of trend based on the trend test using a logistic regression model.
[2]Prevalence difference between 2005 and 2009.
[3]Prevalence difference between the highest and the lowest.
[4]Adjusted by grade and region.
[5]Adjusted by gender, grade, and region.
[6]Adjusted by gender and grade.
*$p<0.05$ (compared to previous year), †$p<0.05$ by trend tests.

Table 2. Adolescents' vegetable consumption rate changes from 2005 to 2009

	Annual prevalence of diet behaviors (95% CI)					Difference		Linear trends[1]		Secular trends[1]	
	2005	2006	2007	2008	2009	Diff1[2]	Diff2[3]	Crude	Adjusted	Crude	Adjusted
Total population	16.9 (16.5 - 17.4)	16.5 (16.1 - 17.0)	16.5 (16.1 - 16.9)	19.8 (19.3 - 20.2)*	17.9 (17.5 - 18.4)*	1.0	3.3	0.037†	0.045†	0.003	0.001
Gender[4]											
Male	18.4 (17.7 - 19.0)	18.0 (17.4 - 18.6)	17.6 (17.0 - 18.2)	21.4 (20.8 - 22.0)*	18.9 (18.3 - 19.4)*	0.5	3.8	0.030†	0.039†	<0.001	-0.002
Female	15.4 (14.8 - 15.9)	15.0 (14.4 - 15.5)	15.3 (14.8 - 15.8)	17.9 (17.3 - 18.5)*	16.9 (16.3 - 17.5)*	1.5	2.9	0.046†	0.053†	0.007	0.005
School type[5]											
Middle	18.4 (17.8 - 19.0)	18.2 (17.7 - 18.8)	17.3 (16.7 - 17.9)	20.7 (20.1 - 21.2)*	19.2 (18.5 - 19.8)*	0.8	3.4	0.026†	0.028†	0.008	0.008
General high	15.4 (14.6 - 16.1)	15.4 (14.6 - 16.1)	16.7 (16.0 - 17.4)	20.2 (19.4 - 21.0)*	17.3 (16.7 - 17.9)*	1.9	4.8	0.060†	0.060†	-0.014†	-0.012
Vocational high	12.1 (10.8 - 13.4)	12.5 (11.6 - 13.5)	12.7 (11.5 - 13.8)	14.8 (13.7 - 15.8)	14.8 (13.5 - 16.0)	2.7	2.7	0.067†	0.072†	0.014	0.014
Region[6]											
Large city	16.3 (15.8 - 16.8)	15.6 (15.2 - 16.1)	15.5 (15.1 - 16.0)	19.5 (18.9 - 20.0)*	17.5 (17.1 - 18.0)*	1.2	4.0	0.047†	0.054†	0.008	0.006
Small city	17.5 (16.8 - 18.3)	17.3 (16.5 - 18.1)	17.3 (16.5 - 18.1)	20.0 (19.2 - 20.8)*	18.4 (17.5 - 19.2)	0.9	2.7	0.030†	0.036†	0.001	-0.002
Rural area	18.4 (16.9 - 19.8)	18.5 (16.8 - 20.3)	18.9 (17.7 - 20.0)	21.5(20.3 - 22.7)*	18.5 (17.1 - 20.0)*	0.1	3.1	0.022	0.028	-0.016	-0.019
Subjective economic status[5]											
Upper	18.1 (17.5 - 18.7)	23.2 (21.8 - 24.6)*	21.9 (20.6 - 23.3)	27.6 (25.8 - 29.3)*	23.4 (21.6 - 25.2)*	5.3	9.5	0.030†	0.041†	-0.009	-0.011
Middle	15.3 (14.6 - 15.9)	16.0 (15.5 - 16.4)	16.2 (15.8 - 16.6)	19.3 (18.9 - 19.8)*	17.6 (17.2 - 18.1)*	2.3	4.0	0.042†	0.049†	0.004	0.002
Lower	15.4 (13.9 - 16.8)	16.0 (14.4 - 17.5)	15.7 (14.4 - 17.1)	18.1 (16.7 - 19.5)	16.6 (15.3 - 17.9)	1.2	2.7	0.032	0.039†	-0.008	-0.011

Vegetable consumption: percentage of students who ate vegetable three or more times per day during the past 7 days before survey.
CI, confidence interval.
[1]Coefficients of trend based on the trend test using a logistic regression model.
[2]Prevalence difference between 2005 and 2009.
[3]Prevalence difference between the highest and the lowest.
[4]Adjusted by grade and region.
[5]Adjusted by gender, grade, and region.
[6]Adjusted by gender and grade.
*$p<0.05$ (compared to previous year), †$p<0.05$ by trend tests.

Table 3. Adolescents' milk consumption rate changes from 2005 to 2009

	Annual prevalence of diet behaviors (95% CI)					Difference		Linear trends[1]		Secular trends[1]	
	2005	2006	2007	2008	2009	Diff1[2]	Diff2[3]	Crude	Adjusted	Crude	Adjusted
Total population	13.4 (12.9 - 14.0)	15.2 (14.6 - 15.7)*	14.8 (14.3 - 15.3)	15.5 (15.0 - 16.0)	14.1 (13.5 - 14.6)*	0.7	2.1	0.010	0.031†	-0.029†	-0.040†
Gender[4]											
Male	19.0 (18.2 - 19.7)	20.4 (19.6 - 21.1)	20.3 (19.5 - 21.1)	20.6 (19.9 - 21.3)	18.4 (17.7 - 19.1)*	-0.6	2.2	-0.008	0.010	-0.031†	-0.040†
Female	7.2 (6.7 - 7.7)	9.3 (8.7 - 9.9)*	8.6 (8.1 - 9.1)	9.8 (9.2 - 10.4)*	9.2 (8.6 - 9.8)	2.0	2.6	0.051†	0.077†	-0.026†	-0.039†
School type[5]											
Middle	15.8 (15.1 - 16.5)	18.8 (18.1 - 19.6)*	18.8 (18.0 - 19.5)	19.1 (18.4 - 19.8)	18.0 (17.2 - 18.7)	2.2	3.3	0.031†	0.032†	-0.038†	-0.039†
General high	9.9 (9.0 - 10.8)	11.4 (10.4 - 12.4)	10.5 (9.7 - 11.2)	11.6 (10.8 - 12.4)	10.4 (9.5 - 11.2)	0.5	1.7	0.005	0.017	-0.022†	-0.031†
Vocational high	7.7 (6.5 - 8.8)	9.5 (8.3 - 10.6)	10.0 (9.0 - 11.0)	11.8 (10.7 - 13.0)	9.0 (7.6 - 10.4)*	1.3	4.1	0.049†	0.057†	-0.060†	-0.068†
Region[6]											
Large city	13.8 (13.1 - 14.5)	15.8 (15.1 - 16.5)*	15.2 (14.5 - 15.9)	16.0 (15.4 - 16.6)	14.6 (14.0 - 15.3)*	0.8	2.2	0.011	0.034†	-0.029†	-0.039†
Small city	13.6 (12.6 - 14.5)	15.0 (14.0 - 16.0)	14.6 (13.7 - 15.5)	15.0 (14.0 - 15.9)	13.5 (12.5 - 14.4)	-0.1	1.5	-0.005	0.017	-0.030†	-0.040†
Rural area	10.4 (8.9 - 12.0)	11.8 (10.5 - 13.0)	12.5 (11.3 - 13.7)	14.5 (12.8 - 16.2)	12.6 (11.3 - 13.9)	2.2	4.1	0.067†	0.090†	-0.033	-0.048†
Subjective economic status[5]											
Upper	15.3 (14.7 - 16.0)	24.5 (22.8 - 26.2)*	25.6 (23.9 - 27.4)	25.1 (23.7 - 26.6)	22.9 (21.4 - 24.4)	7.6	10.3	0.041†	0.060†	-0.065†	-0.074†
Middle	10.9 (10.2 - 11.5)	14.5 (13.9 - 15.0)*	14.2 (13.7 - 14.7)	14.9 (14.4 - 15.5)	13.6 (13.0 - 14.1)*	2.7	3.3	0.009	0.028†	-0.027†	-0.036†
Lower	9.8 (8.6 - 11.0)	11.8 (10.5 - 13.2)	12.1 (10.8 - 13.4)	13.3 (12.2 - 14.4)	12.3 (10.9 - 13.7)	2.5	3.5	0.059†	0.077†	-0.031	-0.045†

Milk consumption: percentage of students who drank milk two or more times per day during the past 7 days before survey.
CI, confidence interval.
[1]Coefficients of trend based on the trend test using a logistic regression model.
[2]Prevalence difference between 2005 and 2009.
[3]Prevalence difference between the highest and the lowest.
[4]Adjusted by grade and region.
[5]Adjusted by gender, grade, and region.
[6]Adjusted by gender and grade.
*$p<0.05$ (compared to previous year), †$p<0.05$ by trend tests.

RESULTS

Figure 1 demonstrates policies that are performed to improve adolescents' eating behavior between 2005 and 2009. In March 2006, MEST recommended a ban on the sale of carbonated-beverages in school and youth-training facilities; their sales have been banned since February 2007 [26]. In July 2006, the School Meal Act was amended, so nutrition teachers were hired and distributed to schools, and nutrition education and nutrition counseling were implemented. From September 2006, the Prevention of Obesity Program was disseminated, and its implementation became mandatory after February 2007 [15]. After March 2008, nutritional labeling on school meals was implemented, and, after March 2009, based on the enactment of a special law on children's safe eating-habit management, Children's Green Food Zones were designated and operated, and quality certification on children's favorite foods and designation of children's health-friendly companies were carried out [15].

Over 5 years, the fruit consumption rate decreased 7.9% from 32.6% to 24.7%, and it changed within a 9.9% range (Table 1). Both before and after adjustment according to gender, school grade, and region, a significant linear decreasing trend was observed, and for the secondary function, a significant ($p<0.05$) convex-shape tendency was observed. For each characteristic, such as gender, type of school, and region, the same tendencies were observed for each stratum. For subjective economic status, a stratum in which the subjective economic status was high or middle showed a significant linear-decrease tendency both before and after adjustments; however, in a stratum with a low status, this trend disappeared after adjustment. Looking at each year, in general, between 2006 and 2007, and between 2008 and 2009, significant decreases were observed, and between 2007 and 2008, a significant increase was observed ($p<0.05$).

The vegetable consumption rate slightly rose 1.0% from 16.9% to 17.9% over 5 years, and the change happened within a 3.3% range (Table 2). Before and after the adjustment of gender, grade, and region, all showed a significant linear-increase tendency, but no quadratic trends were observed. Looking at each year, there was a significant increase between 2007 and 2008, and a significant decrease between 2008 and 2009 ($p<0.05$). For each characteristic, including gender, type of school, and subjective economic status, the same tendencies were observed for each stratum; however, for

Table 4. Adolescents' carbonated-beverage consumption rate changes from 2005 to 2009

	Annual prevalence of diet behaviors (95% CI)					Difference		Linear trends[1]		Secular trends[1]	
	2005	2006	2007	2008	2009	Diff1[2]	Diff2[3]	Crude	Adjusted	Crude	Adjusted
Total population	77.6 (77.0 - 78.3)	75.9 (75.2 - 76.5)*	73.5 (72.8 - 74.1)*	67.1 (66.4 - 67.8)*	66.5 (65.9 - 67.2)	-11.1	11.1	-0.156†	-0.164†	-0.014†	-0.012†
Gender[4]											
Male	82.1 (81.3 - 83.0)	80.5 (79.8 - 81.2)*	78.0 (77.3 - 78.7)*	72.3 (71.5 - 73.1)*	72.5 (71.7 - 73.2)	-9.6	9.8	-0.158†	-0.166†	-0.007	-0.003
Female	72.6 (71.7 - 73.4)	70.7 (69.8 - 71.6)*	68.3 (67.5 - 69.2)	61.3 (60.3 - 2.3) *	59.9 (59.0 - 60.7)	-12.7	12.7	-0.159†	-0.162†	-0.021†	-0.020†
School type[5]											
Middle	76.1 (75.3 - 76.9)	73.6 (72.8 - 74.4)*	71.6 (70.8 - 72.4)*	66.2 (65.4 - 67.1)*	65.7 (64.8 - 66.5)	-10.4	10.4	-0.137†	-0.139†	0.001	0.002
General high	79.0 (77.6 - 80.5)	76.8 (75.5 - 78.0)	73.6 (72.3 - 75.0)*	65.1 (63.7 - 66.6)*	65.6 (64.4 - 66.7)	-13.4	13.9	-0.194†	-0.199†	-0.024†	-0.026†
Vocational high	83.7 (82.0 - 85.3)	83.1 (81.9 - 84.4)	80.8 (79.5 - 82.2)	76.4 (74.8 - 78.0)*	73.2 (70.9 - 75.4)	-10.5	10.5	-0.178†	-0.183†	-0.051†	-0.054†
Region[6]											
Large city	77.7 (76.7 - 78.6)	76.2 (75.4 - 77.1)	74.1 (73.4 - 74.9)*	67.3 (66.4 - 68.2)*	66.1 (65.3 - 67.0)	-11.6	11.6	-0.163†	-0.171†	-0.024†	-0.023†
Small city	77.7 (76.6 - 78.8)	75.4 (74.3 - 76.5)*	72.4 (71.2 - 73.6)*	66.5 (65.2 - 67.8)*	66.6 (65.5 - 67.7)	-11.1	11.2	-0.154†	-0.162†	-0.003	-0.001
Rural area	77.4 (75.6 - 79.2)	76.2 (74.1 - 78.2)	74.8 (73.4 - 76.2)	69.7 (67.8 - 71.6)*	70.3 (68.3 - 72.2)	-7.1	7.7	-0.107†	-0.113†	<0.001	0.002
Subjective economic status[5]											
Upper	77.7 (77.0 - 78.5)	76.5 (74.7 - 78.3)	71.4(69.5 - 73.3)*	68.0 (66.4 - 69.6)	69.2 (67.2 - 71.1)	-8.5	9.7	-0.118†	-0.139†	0.014	0.016
Middle	77.7 (76.8 - 78.5)	75.7 (75.0 - 76.4)*	73.5 (72.9 - 74.2)*	66.9 (66.1 - 67.7)*	66.1 (65.5 - 66.8)	-11.6	11.6	-0.162†	-0.169†	-0.016†	-0.014†
Lower	76.5 (74.7 - 78.3)	77.3 (75.6 - 79.0)	74.7 (72.9 - 76.5)	69.2 (67.4 - 71.1)*	69.4 (67.8 - 71.0)	-7.1	7.9	-0.116†	-0.125†	-0.020	-0.017

Carbonated beverage consumption: percentage of students who drank carbonated beverage one or more times during the past 7 days before survey.
CI, confidence interval.
[1]Coefficients of trend based on the trend test using a logistic regression model.
[2]Prevalence difference between 2005 and 2009.
[3]Prevalence difference between the highest and the lowest.
[4]Adjusted by grade and region.
[5]Adjusted by gender, grade, and region.
[6]Adjusted by gender and grade.
*$p<0.05$ (compared to previous year), †$p<0.05$ by trend tests.

region, no significant tendency was found after analysis in rural areas, unlike in a large or small city.

The milk consumption rate slightly rose 0.7% from 13.4% to 14.1%, and there was a change within a 2.1% range (Table 3). Linear tendency that was not significant before adjustment showed significant linear-increase after the adjustment according to gender, grade, and region, and convex-shape trends were observed both before and after adjustment. Looking at each year, a significant increase was observed between 2005 and 2006, and a significant decrease between 2008 and 2009 ($p<0.05$). For each characteristic, an identical tendencies were observed for each stratum with subjective economic status, but with male students (for gender), general high school (for the type of school), and small city (for region), no significant linear-increase was observed, but only a significant convex-shape tendency.

The carbonated-beverages consumption rate decreased 11.1% from 77.6% to 66.5%, and there was a change within an 11.1% range (Table 4). A significant linear-decrease was observed, both before and after adjustment; a significant convex-shaped tendency was observed, as well. Looking at each year, there were significant decreases in every year, except for 2008 and 2009 ($p<0.05$). For each characteristic in all (gender, type of school, and region), the same tendencies were observed.

The fast-food consumption rate decreased by 9.7% from 70.3% to 60.6%, and there was a change within an 11.1% range (Table 5). Both before and after adjustment, a significant linear-decrease was observed, but not a quadratic trend. Looking at each year, there were significant decreases between 2005 and 2006, as well as between 2007 and 2008; a significant increase ($p<0.05$) was observed between 2008 and 2009. For every characteristic, identical linear decreasing trends were observed with gender, type of school, region, and subjective economic status; convex-shaped tendencies were observed with middle school (for the type of school) and when subjective economic status was high; similarly, convex-shaped tendencies were observed with both general and vocational high school.

The instant noodle consumption rate decreased by 4.5% from 77.3% to 72.8%, and there was a change within a 6.4% range (Table 6). Both before and after adjustment, significant linear-decrease and concave-shaped tendency were observed. Looking at each year, there were significant decreases between 2005-2006 and 2007-2008 and a significant increase in 2008-2009 ($p<0.05$). For each characteristic, the same linear tendencies were observed in every stratum with gender, type of school, region, and subjective economic status. With vocational high school (for type of school), in

Table 5. Adolescents' fast-food consumption rate changes from 2005 to 2009

	Annual prevalence of diet behaviors (95% CI)					Difference		Linear trends[1]		Secular trends[1]	
	2005	2006	2007	2008	2009	Diff1[2]	Diff2[3]	Crude	Adjusted	Crude	Adjusted
Total population	70.3 (69.7 - 70.9)	68.4 (67.8 - 69.1)*	67.4 (66.8 - 67.9)	56.1 (55.5 - 56.8)*	60.6 (60.1 - 61.2)*	-9.7	14.2	-0.140†	-0.156†	0.001	0.007
Gender[4]											
Male	69.7 (68.9 - 70.6)	67.9 (67.0 - 68.7)*	66.9 (66.0 - 67.7)	55.9 (55.0 - 6.8)*	61.2 (60.3 - 62.0)*	-8.5	13.8	-0.127†	-0.145†	0.007	0.013†
Female	71.0 (70.1 - 71.9)	69.1 (68.2 - 70.1)*	68.0 (67.1 - 68.8)	56.4 (55.4 - 57.3)*	60.0 (59.1 - 60.9)*	-11.0	14.6	-0.155†	-0.168†	-0.006	-0.001
School type[5]											
Middle	67.4 (66.7 - 68.2)	64.1 (63.3 - 64.8)*	62.6 (61.9 - 63.3)*	51.9 (51.1 - 52.7)*	56.6 (55.8 - 57.4)*	-10.8	15.5	-0.143†	-0.145†	0.020†	0.021†
General high	75.5 (74.4 - 76.6)	73.6 (72.4 - 74.8)	72.7 (71.7 - 73.6)	60.5 (59.5 - 61.6)*	64.5 (63.5 - 65.5)*	-11.0	15.0	-0.168†	-0.173†	-0.017†	-0.015†
Vocational high	74.9 (73.1 - 76.7)	73.4 (72.2 - 74.7)	73.0 (71.5 - 74.5)	61.2 (59.6 - 62.8)*	65.5 (63.8 - 67.2)*	-9.4	13.7	-0.151†	-0.155†	-0.014	-0.015
Region[6]											
Large city	71.0 (70.2 - 71.7)	68.5 (67.7 - 69.2)*	68.1 (67.5 - 68.7)	56.9 (56.1 - 57.7)*	60.9 (60.1 - 61.7)*	-10.1	14.1	-0.141†	-0.155†	<0.001	<0.001
Small city	70.5 (69.5 - 71.5)	69.0 (67.8 - 70.1)	66.9 (65.9 - 68.0)	55.3 (54.2 - 56.4)*	60.5 (59.6 - 61.4)*	-10.0	15.2	-0.148†	-0.165†	0.003	0.009
Rural area	65.6 (63.7 - 67.5)	65.8 (64.2 - 67.3)	64.8 (63.4 - 66.3)	54.4 (52.6 - 56.2)*	58.9 (57.0 - 60.7)*	-6.7	11.2	-0.105†	-0.117†	-0.006	<0.001
Subjective economic status[5]											
Upper	71.3 (70.6 - 72.0)	66.5 (64.6 - 68.4)*	64.6 (62.9 - 66.4)	56.9 (55.1 - 58.6)*	63.7 (61.9 - 65.4)*	-7.6	14.4	-0.110†	-0.122†	0.048†	0.052†
Middle	69.6 (68.7 - 70.5)	68.8 (68.1 - 69.4)	67.7 (67.1 - 68.3)	56.2 (55.6 - 56.9)*	60.5 (59.9 - 61.1)*	-9.1	13.4	-0.146†	-0.161†	0.002	0.004
Lower	65.0 (62.9 - 67.1)	66.1 (64.2 - 68.0)	65.1 (63.4 - 66.9)	54.4 (52.5 - 56.2)*	59.3 (57.5 - 61.1)*	-5.7	10.6	-0.099†	-0.115†	-0.008	-0.001

Fast-food consumption: percentage of students who ate fast food (pizza, hamburger, and fried chicken) one or more times during the past 7 days before survey.
CI, confidence interval.
[1]Coefficients of trend based on the trend test using a logistic regression model.
[2]Prevalence difference between 2005 and 2009.
[3]Prevalence difference between the highest and the lowest.
[4]Adjusted by grade and region.
[5]Adjusted by gender, grade, and region.
[6]Adjusted by gender and grade.
*$p<0.05$ (compared to previous year), †$p<0.05$ by trend tests.

Table 6. Adolescents' instant noodle consumption rate changes from 2005 to 2009

	Annual prevalence of diet behaviors (95% CI)					Difference		Linear trends[1]		Secular trends[1]	
	2005	2006	2007	2008	2009	Diff1[2]	Diff2[3]	Crude	Adjusted	Crude	Adjusted
Total population	77.3 (76.7 - 78.0)	72.5 (71.9 - 73.2)*	72.4 (71.7 - 73.0)	70.9 (70.2 - 71.5)*	72.8 (72.2 - 73.5)*	-4.5	6.4	-0.050†	-0.046†	0.041†	0.040†
Gender[4]											
Male	80.5 (79.9 - 81.2)	76.5 (75.9 - 77.2)*	76.8 (76.2 - 77.5)	75.8 (75.1 - 76.5)*	77.6 (77.0 - 78.3)*	-2.9	4.7	-0.033†	-0.032†	0.039†	0.039†
Female	73.8 (72.8 - 74.8)	68.0 (67.0 - 68.9)*	67.3 (66.4 - 68.2)	65.3 (64.4 - 66.2)*	67.5 (66.6 - 68.4)*	-6.3	8.5	-0.066†	-0.059†	0.044†	0.041†
School type[5]											
Middle	77.8 (77.0 - 78.5)	73.2 (72.4 - 73.9)*	73.9 (73.2 - 74.6)	72.8 (72.1 - 73.5)	75.1 (74.4 - 75.8)*	-2.7	5.0	-0.030†	-0.030†	0.045†	0.046†
General high	75.1 (73.6 - 76.6)	69.2 (67.9 - 70.5)*	68.3 (66.8 - 69.7)	66.8 (65.4 - 68.1)	69.0 (67.9 - 70.2)	-6.1	8.3	-0.056†	-0.060†	0.042†	0.045†
Vocational high	80.6 (78.9 - 82.2)	78.3 (76.4 - 80.1)	77.1 (75.5 - 78.6)	74.7 (73.2 - 76.2)	75.3 (73.7 - 76.9)	-5.3	5.9	-0.077†	-0.078†	0.01	0.008
Region[6]											
Large city	77.1 (76.2 - 77.9)	72.4 (71.6 - 73.2)*	72.0 (71.2 - 72.9)	70.6 (69.8 - 71.5)	72.4 (71.6 - 73.2)*	-4.7	6.5	-0.052†	-0.048†	0.039†	0.037†
Small city	77.5 (76.4 - 78.5)	71.8 (70.7 - 73.0)*	72.0 (70.8 - 73.1)	70.7 (69.6 - 71.7)	72.9 (71.8 - 74.0)*	-4.6	6.8	-0.046†	-0.044†	0.048†	0.047†
Rural area	78.4 (76.3 - 80.5)	76.3 (75.0 - 77.6)	77.5 (76.2 - 78.8)	74.4 (72.1 - 76.6)	76.8 (75.0 - 78.6)	-1.6	4.0	-0.029	-0.029†	0.018	0.019
Subjective economic status[5]											
Upper	76.2 (75.4 - 76.9)	68.2 (66.2 - 70.2)*	68.7 (66.8 - 70.5)	67.3 (65.6 - 69.1)	70.8 (69.0 - 72.7)	-5.4	8.9	-0.026†	-0.027†	0.053†	0.053†
Middle	78.9 (78.1 - 79.7)	72.7 (72.0 - 73.3)*	72.4 (71.7 - 73.1)	71.0 (70.3 - 71.6)*	72.8 (72.2 - 73.5)*	-6.1	6.5	-0.053†	-0.048†	0.041†	0.040†
Lower	79.6 (77.8 - 81.4)	76.0 (74.4 - 77.7)	75.9 (74.3 - 77.6)	73.2 (71.6 - 74.7)	75.0 (73.3 - 76.6)	-4.6	6.4	-0.063†	-0.062†	0.027†	0.027†

Instant noodle consumption: percentage of students who ate instant noodle one or more times during the past 7 days before survey.
CI, confidence interval.
[1]Coefficients of trend based on the trend test using a logistic regression model.
[2]Prevalence difference between 2005 and 2009.
[3]Prevalence difference between the highest and the lowest.
[4]Adjusted by grade and region.
[5]Adjusted by gender, grade, and region.
[6]Adjusted by gender and grade.
*$p<0.05$ (compared to previous year), †$p<0.05$ by trend tests.

Table 7. Adolescents' confectionary consumption rate changes from 2005 to 2009

	Annual prevalence of diet behaviors (95% CI)					Difference		Linear trends[1]		Secular trends[1]	
	2005	2006	2007	2008	2009	Diff1[2]	Diff2[3]	Crude	Adjusted	Crude	Adjusted
Total population	89.1 (88.7 - 89.5)	87.3 (86.8 - 87.7)*	86.5 (86.1 - 87.0)	83.6 (83.2 - 84.1)*	83.9 (83.4 - 84.4)	-5.2	5.5	-0.117†	-0.126†	0.005	0.010
Gender[4]											
Male	86.8 (86.1 - 87.4)	85.4 (84.8 - 86.0)*	84.0 (83.4 - 84.7)*	80.7 (80.1 - 81.4)*	81.0 (80.2 - 81.7)	-5.8	6.1	-0.119†	-0.128†	<0.001	0.005
Female	91.7 (91.2 - 92.3)	89.4 (88.8 - 90.0)*	89.4 (88.8 - 89.9)	86.9 (86.3 - 87.5)*	87.2 (86.5 - 87.8)	-4.5	4.8	-0.114†	-0.121†	0.012	0.018†
School type[5]											
Middle	88.3 (87.7 - 88.8)	85.4 (84.8 - 86.1)*	84.8 (84.2 - 85.3)	81.4 (80.8 - 82.0)*	81.4 (80.6 - 82.2)	-6.9	6.9	-0.135†	-0.134†	0.015†	0.016†
General high	91.1 (90.3 - 91.9)	90.0 (89.3 - 90.7)	89.0 (88.3 - 89.8)	86.6 (85.9 - 87.4)*	87.2 (86.5 - 87.9)	-3.9	4.5	-0.111†	-0.111†	0.001	0.001
Vocational high	89.1 (87.7 - 90.5)	87.8 (86.7 - 88.9)	87.1 (86.1 - 88.2)	84.1 (82.7 - 85.8)*	84.2 (82.7 - 85.8)	-4.9	5.0	-0.115†	-0.107†	-0.009	-0.015
Region[6]											
Large city	88.1 (87.5 - 88.6)	86.3 (85.7 - 86.9)*	85.7 (85.1 - 86.2)	82.6 (82.1 - 83.2)*	82.4 (81.8 - 83.0)	-5.7	5.7	-0.118†	-0.129†	-0.004	<0.001
Small city	89.9 (89.2 - 90.7)	87.9 (87.1 - 88.7)*	86.9 (86.1 - 87.7)	84.5 (83.7 - 85.3)*	85.3 (84.4 - 86.3)	-4.6	5.4	-0.108†	-0.121†	0.019	0.025†
Rural area	91.8 (90.4 - 93.2)	90.5 (89.5 - 91.4)	90.7 (89.9 - 91.4)	87.6 (86.4 - 88.9)*	88.3 (87.2 - 89.3)	-3.5	4.2	-0.107†	-0.114†	0.006	0.010
Subjective economic status[5]											
Upper	88.9 (88.4 - 89.4)	82.6 (81.0 - 84.3)*	81.9 (80.4 - 83.4)	79.2 (77.8 - 80.7)	81.2 (79.7 - 82.7)	-7.7	9.7	-0.071†	-0.078†	0.031†	0.035†
Middle	89.7 (89.0 - 90.4)	87.7 (87.3 - 88.2)*	87.0 (86.5 - 87.4)	84.1 (83.6 - 84.6)*	84.2 (83.7 - 84.8)	-5.5	5.6	-0.123†	-0.131†	0.004	0.009
Lower	87.6 (86.2 - 89.0)	86.9 (85.4 - 88.3)	84.7 (83.1 - 86.2)	81.6 (80.3 - 83.0)*	81.7 (80.2 - 83.1)	-5.9	6.0	-0.130†	-0.133†	-0.004	<0.001

Confectionary consumption: percentage of students who ate confectionary one or more times during the past 7 days before survey.
CI, confidence interval.
[1]Coefficients of trend based on the trend test using a logistic regression model.
[2]Prevalence difference between 2005 and 2009.
[3]Prevalence difference between the highest and the lowest.
[4]Adjusted by grade and region.
[5]Adjusted by gender, grade, and region.
[6]Adjusted by gender and grade.
*$p<0.05$ (compared to previous year), †$p<0.05$ by trend tests.

every stratum except for rural area (for region), concave-shaped tendencies were also observed.

The confectionary consumption rate decreased 5.2% from 89.1% to 83.9%, and there was a change within the 5.5% range (Table 7). Both before and after adjustment, a significant linear-decrease was observed; however, no quadratic trend was observed. Looking at each year, between 2005-2006, and 2007-2008, significant decreases were observed ($p<0.05$). For every characteristic, identical decreasing trends were observed in every stratum with female students (for gender), middle school (for type of school), and small city (for region), and a significant concave-shaped tendency was observed with high subjective economic status.

DISCUSSION

Commencing in 2005, we observed secular trends in adolescents' dietary behavior for 5 years. In every index, significant linear changes have been observed, and quadratic trends were also observed in some indices. The size of the linear slope was closely related to a total change amount or fluctuation range. In other words, for the carbonated-beverages consumption rate or fast-food consumption rate, whose total change amount or fluctuation range was the highest, there was a linear tendency with a big slope; the milk or vegetable consumption rates, which were rather low, showed a linear tendency with a low slope. In the case of milk consumption especially, the linear tendency lost its significance in some strata, but convex-shape tendencies were observed in every stratum. On the other hand, with the vegetable consumption rate, no quadratic tendency was observed.

When considering the directions of change, in general, every index, excluding the fruit consumption rate, changed in the desirable direction. The fruit consumption rate showed a linear decreasing tendency over 5 years, but when carefully observed, it increased 2.0% from 2005 to 2008 and rapidly decreased 9.9% between 2008 and 2009. With 2008 as a starting point, direction changed from an increase to a decrease, and in reality, a significant convex-shaped tendency was observed. What one needs to pay attention to is that these undesirable directional changes were also observed in other dietary behavior indices, although there might be a difference in the degree of change. The common undesirable changes between 2008 and 2009 may be the effects of dietary behavior being altered or an error in the surveying

process. However, considering the fact that KYRBWS used a sampling method that ensures representativeness, in which data validity and reliability are qualified, the possibility of sampling or non-sampling error would be somewhat low [23,27,28]. On the other hand, the causes for the worsening of the adolescents' dietary behavior could be found in external factors. Above all, the reasons could come from deterioration in the economic environment, in general, or aggravated social inequality. According to previous studies [29], low socioeconomic level is highly related to inappropriate dietary behavior, and the global economic crisis [30] that occurred after the second half of 2008 might have caused a negative effect on adolescents' dietary behavior. In addition, considering the fact that the Gini inequality index for market income (an index that reflects inequality of actual income) rose to 0.298 in 2005, 0.319 in 2008, peaked at 0.320 in 2009, and then decreased to 0.315 in 2010, the fact that Korea's social inequality became rather aggravated between 2008 and 2010 also supports this hypothesis [31]. Whether the deterioration of the dietary behavior observed during this period is a temporary phenomenon due to external causes, or will continue to worsen, is uncertain; thus, continuous monitoring and establishment of adequate countermeasures are required.

During the past 10 years, in Korea, various government-led comprehensive plans have been established with the purpose of improving adolescents' dietary behavior. These comprehensive plans include the Korean Health Plan 2010; the National Obesity Prevention Program; the Five-year Policy for Children and Adolescents (2008-2012), led by MOHW; the Students' Health Promotion Plan (2007-2011); the Comprehensive Measures for School Meal (2007-2011), led by MEST; the Children's Food Safety Management(2007-), led by the Korea Food and Drug Administration; and the Children's Health Plan (2007), led by the Advisory Commission of President Sustaining Advancement [15]. These plans include many policies; however, there have been criticisms of the plans' lack of coordination and/or control processes, which lead to a lack of consistency and redundancy issues; in addition, there are plans, such as the National Obesity Prevention Programs, that have not yet been promoted [15].

Based on these government-led comprehensive plans, and according to the approach method of policies which have been pushed ahead until the present, these plans can be classified as four categories; individual's behavior improvement policy, family environment improvement policies, school environment improvement policies, and community environment improvement policies [4,7]. As a result, nutrition education, nutrition counseling, and obesity prevention programs are categorized as "individual behavior improvement policies," even if they are carried out by the school and have as their direct purpose the improvement of one's dietary behavior. Such actions as nutritional labeling of school meals, and the prohibition of the sale of carbonated-beverages, which are carried out by the school, are categorized as the school's "internal environment improvement policies," due to the fact that their purpose is to establish friendly environments that help students attain desirable dietary behavior, rather than direct improvement of the students' dietary behavior. Aside from that, designating a Green Food Zone, quality certification of children's favorite foods, designating children health-friendly companies, prohibition of the sales of emotion-impediment food, a nutrition signal light marking system, and restrictions of advertisement on high-calorie/low-nutrition food, have a purpose of constructing a friendly environment; thus, they were categorized as "community environment improvement policies," but there were no policies related to family environment improvement policies. Out of many community environment improvement policies, such policies as prohibition of emotion-impediment food, a nutrition signal light marking system, and restrictions of advertisements on high-calorie/low-nutrition food were performed after 2010; thus, they were excluded from the analysis [32,33].

Nutrition education and/or nutrition counseling, whose purpose is the direct improvement of adolescents' dietary behavior, commenced during the second half of 1990 at some public health centers; after the second half of 2000, almost all the public health centers started to promote the activities. However, these businesses, led by public health centers, are being operated in a limited manner and are targeting few schools within the region; additionally, these programs were neither greatly expanded, nor markedly reduced during the period 2005-2009 [15]. Separate from these programs, in July 2006, the MEST pushed ahead distribution of a nutrition teacher and the implementation of a nutrition counselor, according to an amendment to the School Meal Act; in September 2006, an obesity prevention program was disseminated; in February 2007, the management of this program was mandated. However, from 2006-2007 (the year in which nutrition education and/or counseling might have quantitatively increased through the obesity prevention program), data showed that adolescents' consumption of fruits, vegetables, and milk rather decreased, and the consumption of fast-food, instant noodles, and confectionary slightly (but not signifi-

cantly) decreased. From this result, it could be seen that the effect of the program carried out by MEST did not demonstrate a marked success during 2006-2007. However, although it is difficult to distinguish and compare the effect of the ban on carbonated-beverages in schools, or the nutritional labeling of school meals, which were carried out after 2007, it is assumed that the obesity prevention programs could have had some effect on the improvement of dietary behavior observed from 2007-2008.

From our study, the reason it is difficult to confirm the effect of nutrition education or counseling, which are known to be the most effective methods for the improvement of an individual's dietary behavior [34], is twofold. First, the applicable range of the policies is limited. In general, nutrition counseling is performed individually, so it is difficult to be put into effect throughout the student population in a short period of time; importantly, if the counseling is carried out as a part of an obesity program, the targets are limited to a high-risk group, not the entire student. Thus, the proportion of the students who received nutrition education or nutrition counseling was very small, which could have diluted the effect. Second, the difficulty in confirming the effect of nutrition education or counseling may be due to the lack of continuity of the two activities. In previous studies that assessed these effects, a well-planned series of nutrition education or counseling programs were implemented [5]; however, in schools, because of a limitation of manpower, time, and cost, the programs were unable to be applied as designed and were conducted only once. In foreign countries, there is criticism that education and counseling carried out to improve an individual's behavior directly are not effective (despite its ultimate positive effects), because of the high cost and limitation of applicable subjects [6,8], and interest in policies that improve the environment, especially the school environment, has increased [4,9,10].

The effects of such policies as nutritional labeling of school meals, or a ban on carbonated-beverages in schools for improving the eating lifestyle inside schools for healthy dietary behavior, are as mentioned below. Nutritional labeling of school meals, starting with the pilot project in September 2007, was mandatory in every school by 2008. Between 2007 and 2008, the fruit and vegetable consumption rates significantly increased, but the carbonated-beverage, fast-food, instant noodle, and confectionary consumption rate significantly decreased. In March 2006, a ban on carbonated-beverages in the schools was recommended and fully enforced in February 2007. For this reason, it was reported that, according to an investigation led by MEST, the ban rate rose from 52.5% in May 2006, to 84.2% in October 2006, to 99.8% in August 2007 [27]. This policy was implemented because ingestion of carbonated-beverages can be the reason for children-adolescence weight gain and obesity [35]. Actually, in California, USA, the restriction of sales of carbonated-beverages in school is effective in restraining child obesity. In contrast, other studies reported that its effects couldn't be observed in other regions [36]. According to an analysis in our study, the carbonated-beverages consumption rate over the last 5 years significantly decreased, in general, indicating that the ban of the sale of carbonated-beverages was effective. In particular, from 2005 to 2006, that is, before and after the ban was recommended as an appropriate step, between 2006 and 2007, that is, before and after it was mandated, and between 2007 and 2008, that is, before and after it was implemented in almost all schools, significant decreases were observed. However, from 2008 to 2009, a decreasing trend was observed. It is difficult to judge whether this decreasing phenomenon was temporary, or whether its effect will be limited in the future. It appears as if more data must be accumulated in the future to arrive at a solid trend.

The Green Food Zone, although it is not a school-based policy, is used for building a friendly environment for desirable dietary behavior on the community level. The Green Food Zone is a system that targets schools from elementary school to high school, with a designated region within 200 m from the border of each school, in order to construct a safe and sanitary food sales environment for young people through a concentrated management program. Managed by supervisors, inside the Green Food Zone, sales of emotional-hindrance and low-quality food for children is banned [26]. This policy started as pilot project in 12 schools in March 2007; after which, it expanded to 54 schools in 2008; and was then fully implemented in March 2009. Out of 9053 schools as targets, 8051 regions were selected and managed by December 2009 [37]. In order to estimate the effect of this policy, excluding the pilot period that was limited to nearby elementary schools, when looking at the changes of dietary behavior before and after March 2009, which was the time period that the policy was pushed ahead to overall enforcement, it showed that fruit and vegetable consumption rates significantly decreased, and fast-food and instant noodle consumption rates increased; therefore, the results were less than stellar. This phenomenon may be explained by low effectiveness,

because the Green Food Zones are not working in a practical manner. These policies, during the pilot period, were carried out targeting a limited number of schools; in September 2009, six months after the policies were fully implemented and the fifth yearly KYRBWS investigation was conducted, it was assumed that not enough time had elapsed since the actual system was executed. In addition, the ban on the sale of food outside school is directly related to the profit of nearby storekeepers; thus, it is possible that an actual ban on sales of food outside school may not have occurred. In reality, a survey carried out by the Council of Consumer Organization, children's emotional-hindrance food, or unsanitary food was still being sold, and there was a report that 56.3% of the stores at the designated regions did not know the actual facts [38]. Second, it might be because of external factors, such as the economic crisis that started in the second half of 2008. Despite all the speculation, it may not be fair to conclude that the Green Food Zone policy has failed just from these results, so there may be a need to re-evaluate the program after sufficient time has passed for the program to render sound performance data.

Our study has some limitations. First, this study analyzed data over 5 years, which was a rather short time period to grasp the secular trends; because of this, even on the methodological side, we considered only linear and quadratic tendencies, but couldn't consider cubic or quartic trends for a fluctuation aspect. Second, in terms of grasping the effect of the policies, it was unclear in judging whether a specific policy had an effect on each individual that was targeted for analysis. Thus, its effects were only able to be grasped and understood in a limited manner; when the policies were simultaneously pushed ahead, it was unable to distinguish which effect belonged to which policy. Third, we couldn't control the effect of various external factors that might have effects on a change in dietary behavior, such as family, economy, and structure of food provisions. According to the ecological model, a health behavior model, many macro-level factors, such as politics, economy, and culture, were involved in complicated ways; they have mutually close relevance, and have an effect on dietary behavior [7]. However, it is known that these environmental factors have a limitation in that they are not able to specify the interaction with the effects. In other words, understanding how far the particular environmental factor has an effect, and understanding how it interacts with other factors, is particularly difficult [7]. Thus, it was not possible to restrict the effects of environmental factors. Lastly, by excluding the 3rdstudents in high school from KYRBWS in 2005, the possibility of selection bias increased. Considering previous studies that showed inappropriate dietary behavior as adolescents grew older [32], the results of 2005 present the possibility of being distorted to a more desirable direction than reality, which could work toward decreasing the changes of desirable direction in observing secular trends. Despite that, almost all dietary behavior significantly changed in a desirable direction, and we are able to confirm the effect of the ban on carbonated beverages that was carried out between 2005 and 2006. In addition, after excluding the 3rd grade high school students in the analysis, identical results were observed; thus, it is judged that an intervention of selection bias did not have much effect on the conclusion of the research.

Despite these limitations, this study is worthwhile because it is the first one, to our knowledge, that analyzed secular trends of the adolescents' dietary behavior using representative data, and evaluated the effects of a government nutrition policy using the ITS method.

According to this study, nutrition education and/or nutrition counseling, whose range of application was limited, had a relatively small effect on improving dietary behavior of adolescents, even if their effects were certified through the previous studies. On the other hand, although there has been a debate, policies for environment improvement, such as nutritional labeling of school meals, and a ban on carbonated-beverages, appear more effective. School-based policies (a ban on carbonated-beverages in the schools) especially demonstrated that one can not only secure forcibleness and effectiveness rather easily, compared to other communities, but by shutting off opportunities for the students to be exposed to an undesirable environment, the policies were able to naturally induce changes in dietary behavior and support, so that long-lasting changes could be realized-hence the reason for the measures being so effective [9,10]. Meanwhile, because not enough time has passed since the overall enforcement of the Green Food Zone concept, it appears as if additional future assessment is required. Taking into account the fact that there exists an economic conflict with near-the-zone merchants, coupled with its operation not being generally known to stakeholders, there should be active advertisement, as well as an effort to secure its effectiveness through more strict supervision.

To conclude, the policy for the environment improvement was more effective than the policies for direct individual behavior improvement, in terms of improvement of

adolescents' dietary behavior, and the more forcibleness and effectiveness, the better. For improvement of Korean adolescents' dietary behavior, policies for environment improvement that are forcible and effective need to be implemented for building a friendly environment centered around schools, and in keeping with the aforementioned aspects, practice and assessment of policies, based on continuous monitoring of the long- and short-term effects, will be necessary.

CONFLICT OF INTEREST

The authors have no conflicts of interest with the material presented in this paper.

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