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Analysis on the Relationship between Eating Behavior, Physical Activities and Youth Obesity: Based on the Korea Youth Risk Behavior Survey for High School Students in 2016~2018

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Abstract: In this study, a total of 94,511 surveys were used for the analysis, using raw data from the recent 3 years (2016–2018) of the Korea Youth Risk Behavior Survey (KYRBS) to compare differences in obesity rates based on eating behavior and physical activity among high school students. The cross-analysis and logistic regression were performed in the composite sample design using the SPSS 25.0 statistical package. The results are as follows. First, the more physical activity male students have, the lower the obesity rate. Female students, however, showed a minor difference. Second, the group that drinks the soda was 1158 times more likely to be obese than the group that does not drink the soda, and third, the group that eats the fast food was 1129 times more likely to be obese than the group that does not. Fourth, students belonging to male or female schools had a 1230 times higher obesity rate than coeducational students. Fifth, the obesity rate was 1150 times higher for second grade and 1263 times higher for third grade compared to the first grade. Finally, there was no significant difference related to the nutrition education. It is suggested that, to fight youth obesity in high school students, institutions need to raise public awareness of this problem through information campaigns aimed at improving and fostering potentially existing educational measures.

Keywords: youth obesity; body mass index(BMI); eating behavior; physical activity; Korea youth risk behavior survey(KYRBS)

1. Introduction

Over the past 40 years, the obesity rate among teenagers has increased 10 times more [1]. Already, 30% of the world population belong to overweight or obesity [2], and obesity is one of the most serious public health problems in the world [3]. Considering that youth health and obesity levels are important factors that predict the health of adulthood [4]. In addition, it is very important to keep health and prevent obesity through regular physical activities during high school [5]. Especially considering the reality of teenagers, such as the increase of westernized diet and the decrease in physical activity, it is important to introduce an obesity arbitration program based on an environmentally adjustable aspect for the prevention and management of obesity [6].

According to a major U.S. survey, the obesity rate among elementary school students more than doubled, which is from 6.5% in 1980 to 17% in 2006, and more seriously, the obesity rate among teenagers more than tripled, which is from 5% to 17% during the same period [7]. In Korea, the obesity rate among teenagers has increased continuously from 12.3% in 2012 to 16.5% in 2016, and the obesity rate has increased as the school year goes up [8]. Obesity in childhood and teenagers can lead to adult obesity and complications, and even if it does not lead to adult obesity, it will have a significant

impact on the increase in the rate of disease relating to obesity [9]. In particular, childhood obesity does not only contribute to adult diseases, but also reduces physiological functions and negatively affects emotional functions, such as negative physical atrophy, self-esteem and attention loss [10,11]. These obesity-related diseases have confirmed to incur about 1.3638 trillion in economic costs, and it is a serious social problem [12].

A study by Moon and Lee [13] on youth obesity found that people consumed more soda, fruits, fast food, instant noodles, and snacks in the underweight group than in the obese group, while studies by Heo, Nam, Lee and Chung [14] also showed lower levels of consuming soda and instant noodles in the obese group than in the non-obese group. Studies on physical activity showed that the more physical activity decreased, the lower the rate of participation in school physical education classes in adolescents in obese groups [15] and the lower the rate of the obese group exercising compared to non-obese groups was, in particular, the great difference was in muscle-strengthening movements [13]. Kim's research [16] showed an increase in the number of low-weight, obese, normal, and overweight people from the ratio of carrying out high-strength exercises. In a study by Lee and Kim [17], not only the overall amount of physical activity appears to be small in obese groups, but similarly the chances of implementing strenuous physical activity and muscle strengthening exercises in obese groups were low. The higher the BMI was in relation to the internet, the longer children and teenagers in obese groups watched TV or played games, and TV addiction had a significant relationship with the BMI [15].

Such problems with childhood and youth obesity have been considered important. In the case of advanced countries such as Europe, numerous efforts and research are needed to solve this problem. However, although many studies have been conducted regarding this problem, it is difficult to find successful cases through research. In particular, studies on obesity mediation between elementary and middle school students, but studies on obesity among high school students appear to be extremely rare. Therefore, this study uses data from the recent 3 years of the KYRBS to identify the risk of obesity due to factors such as eating behavior of high school students and physical activity in schools. The purpose of this study is to utilize the data as basic data for the study of programs for youth obesity and the development of education programs in schools based on the results.

2. Literature Review

2.1. Obesity in Youth

Obesity is a condition that causes major non-infectious chronic health problems due to excess accumulation of adipose tissue in the body [18]. Obesity is measured using BMI, waist circumference and Waist and Hip Ratio (WHR) [15]. BMI (=weight (kg)/{height (m)}^{2}) is easily measurable and is used as a representative indicator of obesity. The obesity rate among teenagers in Korea continuously increased due to college entrance exams and excessive nutrition, binge eating, poor eating behavior, diet, and lack of exercise [19]. Whitaker et al. [20] showed that while there is a 10% chance that non-obesity teens will lead to adult obesity, managing obesity in adolescence was important because 50% of overweight or obesity teens are likely to lead to adult obesity. Obesity in the growth phase leads to adulthood, which has a significant effect on subsequent health conditions and causes metabolic abnormalities [21]. Obesity in childhood and adolescence can cause emotional instability and mental disorders such as depression due to the disproportionate development of the body [22], and causes diabetes, hyperlipidemia, high blood pressure, arteriosclerosis, and cardiovascular disease, which are health-supporting impediments [23].

2.2. Body Mass Index (BMI)

Body Mass Index (BMI) is a widely used obesity-related measure not only because it is easy to calculate body shapes based on height, but also because it is highly reliable and has a high correlation with body fat [24]. In addition, BMI is one of the measurement methods of obesity along with

measurement of the standard weight, WHR, and is generally used by researchers based on reports of height and weight [17,25,26]. There were a great number of studies used BMI.

A high BMI is associated with a high mortality rate; in addition, a BMI that is too low is also found to be correlated with a high mortality rate [27]. BMI is a standard used in adults to distinguish underweight, overweight, and obesity by dividing weight by the square of the height(kg/m^2) using height and weight. BMI is used to assess risk factors related to obesity prevalence and obesity [28].

According to the provisions of the Korean Society, BMI < 18.5 is classified as underweight, 18.5 ≤ BMI < 23.0 as normal, 23.0 ≤ BMI < 25.0 as overweight, and BMI ≥ 25.0 as obesity [29]. According to the preceding study on the relation of influence with BMI, Yim and Kim [30] confirmed that there is a significant impact on the BMI on the Korean youth's properties, eating behavior and subjective health. In addition, Jo and Kim [31] said that physical self-concepts and immersion significantly affect BMI as factors affecting BMI, while Jang and Son [32] reported that differences in the use of the transportation affect BMI.

2.3. Eating Behavior

Eating behavior can be defined as a habit formed repeatedly by social, literary, and psychological influences within a group [31]. Nutrition, which directly affects a person's physical growth and health, is achieved through a desirable diet. This individual eating behavior is shaped by local, social, and cultural environmental factors and psychological and physiological factors [33]. Therefore, eating behavior is ultimately social, and the formation of certain eating behavior is a powerful symbol of individual identity and an expression of social differentiation [34]. The snack culture is very developed, especially among Korean teenagers who spend most of their time in schools and institutes. However, most of these snacks are out of control from their parents [35]. Proper eating behavior can be seen as a very important factor, especially since the number of obese teens is increasing due to the hypernutrition and lack of the exercise, which is connected with economic growth and westernized diet.

2.4. Physical Activity

Gallahue [27] noted that physical activity is an activity that emphasizes the acquisition of motor control and operational skills based on the developmental stages of each infant. Physical activity is defined as any physical movement that results in an increase in energy consumption through large-scale muscle activities, including any physical activity that occurs in performing daily or tasks other than exercise or sports [36]. Various studies have been conducted at the inside and outside of the country on the relationship between adolescent obesity and physical activity environment [37]. In particular, many attempts have been made to check the impact of the school environment on teenagers' physical activities, obesity and health [38–40]. In most prior studies, strengthening physical education by requiring physical education and expanding the time scale of physical education is seen as having a significant effect on improving the physical activity of teenager. However, the effects of this education on the prevention and management of obesity are showing inconsistent results [41]. This means that the compilation and reinforcement of physical education within the regular curriculum will not be effective. Indeed, it emphasizes that the content of education should be structured in a way that improves both the amount and intensity of physical activity so that meaningful effects can be expected [42]. In this study, the number of physical activities, number of muscle movements, number of physical training hours, and degree of stress awareness were used for the analysis as factors indicating the degree of physical activity in the KYRBS.

3. Methodology

3.1. Data and Sample

This study used raw data from the KYRBS conducted by the Korea Centers for Disease Control and Prevention to examine the link between youth obesity and high school students' eating behavior and

physical activities. The sampling process was divided into population stratification, sample allocation and sampling stages. In the population stratification phase, 39 local counties and school-level (middle schools, general high schools, and specialized high schools) were used as stratification variables to divide the population into 117 layers. The local county classified 17 cities and provinces into large cities, small cities and counties, and then classified them into 39 groups considering geographical accessibility, number of schools and population, and living conditions. In the sample allocation phase, the sample size was 400 middle and high schools. Then, five middle and high schools were allocated to each of the 17 cities and provinces. The proportional allocation method was applied so that the population composition and sample composition costs of each stratification variable match. The sampling method was used to extract stratified colonies. The primary extraction unit was the school and the secondary extraction unit was the class. Anonymous self-entry online survey was conducted on all students in the sample-selected classes. Students with long-term absenteeism, special disabled children, and deciphering disorders were excluded from the sample [43]. Korean Youth Risk Behavior Survey is the open data. In addition, this survey was also done by the Ministry of Health and Welfare, and therefore, this paper does not need to get the IRB. In additions, there are so many papers that did not get the IRB even though they are using KYRBS [38,39].

KYRBS was performed on an anonymous, self-entering online survey of middle and high school students and a single computer was assigned to a sample class student in a school computer room with Internet access, and the survey was conducted randomly. The analysis targets high school students who participated in the KYRBS for 3 years from 2016 to 2018. The distribution by year totaled 94,511, with 33,309 (35.25%) in 2016, 31,391 (33.21%) in 2017 and 29,811 (31.54%) in 2018. Gender was based on 48,168 (50.97%) male and 46,343 (49.03%) female students. There were 30,780 (32.57%) fist graders, 31,909 (33.76%) second graders and 31,822 (33.67%) third graders.

3.2. Variable Description

3.2.1. Body Mass Index (BMI)

BMI is a standard used in adults to distinguish underweight, overweight, and obesity by dividing weight(kg) by the square of the height(m) using height and weight. In this research, BMI < 18.5 is underweight, $18.5 \leq$ BMI < 23.0 is normal, $23.0 \leq$ BMI < 25.0 is overweight, and BMI ≥ 25.0 is classified as obese in accordance with the provisions of the Korean Society for the Study of Obesity.

3.2.2. General Characteristic

The demographic factors used in the analysis of this study are 'What is your gender?' (male and female), 'What is your grade? (1st grade, 2nd grade, 3rd grade), academic performance (upper, mid-upper, middle, middle-low, low), Economic Condition (upper, mid-upper, middle, middle-low, low), and Type of School (coeducation, etc.). The questions asked in the survey are described in Table 1.

Table 1. Questionnaires based on variables.

	Variable	Question
General Characteristics	Academic Performance	In the last 12 months, what has your academic record been?
	Economic Condition	What is the financial condition of your home?
	Type of School	Male, female, coeducational.

Table 1. *Cont.*

	Variable	Question
Eating Behavior	Breakfast frequency	In the last 7 days, how many days have you had breakfast (except for milk or juice)?
	Soda	How often have you drunk soda in the last 7 days?
	Fast food	How often have you eaten fast food such as pizza, hamburger, and chicken in the last 7 days?
	Eating behavior education	In the last 12 months, have you received training in school (including classes, broadcasting, and education in the auditorium) on nutrition and eating habits?
Physical Activity	Physical activity	In the last 7 days, how many days has your heart rate increased more than usual or your body activity (regardless of type) totaled more than 60 minutes a day?
	Muscular exercise	In the last 7 days, how many days have you done push-ups, sit-ups, weight lifting, dumbbells, iron bars, and parallel bars?
	PE class	In the last 7 days, how many times have you worked out in the playground or the gym in the PE class?
	Stress	How much stress do you usually feel?

3.2.3. Eating Behavior

To analyze the eating behavior of the subjects, breakfast frequency (less than once a week, one to three times a week, four to six times a week, everyday), soda intake frequency (less than once a week, one to two times a week, more than three times a week) and fast food intake frequency (less than once a week, one to two times a week, more than three times a week), and having the education of nutrition and eating behavior (whether they experienced or not). The questions asked in the survey are described in Table 1.

3.2.4. Physical Activity

Factors indicating the degree of physical activity were the number of physical activities (less than once a week, one to two times a week, more than three times a week) and the number of muscle exercise (less than once a week, one to two times a week, more than three times a week) and the number of physical education (less than once a week, once a week, twice a week, more than three times a week), and the degree of stress recognition (greatly felt, felt a lot, felt, felt a little, not felt). The questions asked in the survey are described in Table 1.

3.3. Analysis Method

The empirical analysis of this study was performed by the IBM SPSS 25.0 Statistical Package. The KYRBS is characterized by a complex sample design that has undergone steps such as stratification, clustering, and multi-stage sampling, so errors can be minimized and accurate only when weights, clusters and stratification are taken into account in the statistical analysis process. Elements of the complex sample were utilized variables (STRATA), colonies (CLUSTER), and weights (W) in the planned variables. Also, school classification was used as a group for high school-oriented research and separated for comparison between male and female students. The cross tabulation analysis and chi-squares were performed to test the significance use of the variables such as general factors (grade, academic performance, economic condition, school type) and diet factors (frequencies of breakfast, frequency of drinking soda, frequency of eating fast food, presence of nutrition and diet education), and physical activity factors (day of physical activity, number of days of muscle movement, time of physical education, and stress level) according to the body type of high school students. In addition, the logistic regression of the complex sample identified the odds ratio in order to determine the estimate of

the major factors and the relative risk of obesity. Obesity was classified into groups with a BMI over 25 and below to identify odds of obesity for each factor.

4. Results

4.1. Relationship between General Characteristics and Youth Obesity

Table 2 shows the results of cross-analysis and chi-square test of complex samples to find out the link between youth obesity and general characteristics. According to the body type distribution of boys and girls, boys were 12.9% underweight, 50.0% normal, 15.4% overweight, and 21.8% obesity, while girls were 16.0% underweight, 60.1% normal, 12.9% overweight, and 11.0% obesity. The overall obesity rate was twice as high for boys as girls, the survey showed. The difference in BMI by grade indicates that both males and females are overweight and obese in higher grades. In particular, male students showed a greater increase than female students. The percentage of overweight students in their academic performance did not make much difference, but the obesity rate was found to have a large distribution of obese students in the relatively low-performing group. Comparing the differences between economic conditions, male students found that the distribution of underweight and obese students in the lowest economic bracket, female students, saw an increase in the proportion of underweight with higher economic condition, female students indicated increased in the proportion of the obesity with lower economic condition. Finally, in school types, co-education students have a lower obesity rate. In all of these four general characteristics, the obesity rate showed statistically significant differences in both the value of chi-square and the probability of significance.

4.2. Relationship between Eating Behavior and Youth Obesity

Table 3 shows the results of cross-analysis of complex samples and chi-square test verification to find out the link between eating behavior and youth obesity. In terms of eating behavior, we compared the frequency of breakfast, frequency of soda intake, frequency of fast food intake, and nutrition and education of diet. There was no significant difference in the frequency of breakfast for boys, but there was a significant difference for girls. In particular, analysis showed that the percentage of overweight and obese people in groups that do not eat breakfast at all and those who eat daily was slightly lower. Comparing body shapes based on the frequency of soda consumption and the frequency of fast food consumption, both male and female students showed significant differences. According to the frequency of soda consumption and fast food consumption, male students had higher obesity rates in the group. On the other hand, female students showed statistically significant differences, but they were judged to be somewhat lacking in interpreting the link between frequency of intake and obesity. In addition, a comparison of body shapes based on nutrition and diet education did not show significant differences between groups with and without training experience.

Table 2. Relationship between General Characteristics and youth Obesity.

		Male (n = 48,168)					Female (n = 46,343)				
		Underweight	**Normal**	**Overweight**	**Obesity**	χ^2 ***(p)***	**Underweight**	**Normal**	**Overweight**	**Obesity**	χ^2 ***(p)***
Grade	1st	2612 (16.6%)	7899 (50.2%)	2219 (14.1%)	3005 (19.1%)	46,605.0 (<0.001)	2753 (18.3%)	9027 (60.0%)	1730 (11.5%)	1535 (10.2%)	44,877.0 (<0.001)
	2nd	2107 (12.8%)	8199 (49.8%)	2519 (15.3%)	3648 (22.1%)		2440 (15.8%)	9360 (60.6%)	1962 (12.7%)	1699 (11.0%)	
	3rd	1517 (9.5%)	7985 (50.0%)	2651 (16.6%)	3817 (23.9%)		2251 (14.2%)	9464 (59.7%)	2267 (14.3%)	1871 (11.8%)	
Academic Performance	upper	825 (13.3%)	3307 (53.3%)	949 (15.3%)	1123 (18.1%)	90.15 (<0.001)	735 (18.3%)	2495 (62.1%)	470 (11.7%)	313 (7.8%)	315.86 (<0.001)
	mid-upper	1390 (12.5%)	5607 (50.4%)	1724 (15.5%)	2414 (21.7%)		1884 (16.6%)	7015 (61.8%)	1385 (12.2%)	1067 (9.4%)	
	middle	1731 (12.5%)	6980 (50.4%)	2174 (15.7%)	2964 (21.4%)		2380 (16.3%)	8996 (61.6%)	1782 (12.2%)	1446 (9.9%)	
	middle-low	1472 (13.2%)	5399 (48.4%)	1684 (15.1%)	2599 (23.3%)		1726 (14.7%)	6799 (57.9%)	1667 (14.2%)	1538 (13.1%)	
	low	794 (13.6%)	2795 (47.9%)	881 (15.1%)	1372 (23.5%)		708 (15.3%)	2541 (54.9%)	653 (14.1%)	727 (15.7%)	
Economic Condition	upper	566 (11.8%)	2411 (50.3%)	772 (16.1%)	1045 (21.8%)	75.14 (<0.001)	492 (18.2%)	1637 (60.5%)	316 (11.7%)	260 (9.6%)	255.77 (<0.001)
	mid-upper	1489 (11.9%)	6256 (50.0%)	1939 (15.5%)	2828 (22.6%)		2036 (17.4%)	7103 (60.7%)	1404 (12.0%)	1159 (9.9%)	
	middle	2918 (13.1%)	11272 (50.6%)	3453 (15.5%)	4656 (20.9%)		3690 (15.8%)	14,270 (61.1%)	2943 (12.6%)	2429 (10.4%)	
	middle-low	944 (13.9%)	3327 (49.0%)	1005 (14.8%)	1514 (22.3%)		987 (14.0%)	4003 (56.8%)	1043 (14.8%)	1015 (14.4%)	
	low	300 (16.7%)	797 (44.4%)	255 (14.2%)	445 (24.8%)		209 (13.6%)	807 (52.6%)	264 (17.2%)	256 (16.7%)	
Type of School	coeducation	3966 (14.2%)	14,273 (51.1%)	4944 (17.7%)	5614 (20.1%)	182.21 (<0.001)	4466 (17.4%)	15,579 (60.7%)	3080 (12.0%)	2541 (9.9%)	23,798.35 (<0.001)
	etc.	2287 (11.3%)	14,273 (48.6%)	3278 (16.2%)	4816 (23.8%)		3019 (14.6%)	12,282 (59.4%)	2853 (13.8%)	2543 (12.3%)	
Total		n = 6087 (12.9%)	n = 23,350 (50.0%)	n = 7046 (15.4%)	n = 10,122 (21.8%)		n = 7173 (16.0%)	n = 26,845 (60.1%)	n = 5837 (12.9%)	n = 5022 (11.0%)	

Table 3. Relationship between Eating Behavior and Youth Obesity.

		Male (n = 48,168)					Female (n = 46,343)				
		Underweight	**Normal**	**Overweight**	**Obesity**	χ^2 ***(p)***	**Underweight**	**Normal**	**Overweight**	**Obesity**	χ^2 ***(p)***
Breakfast frequency	Less than once a week	1025 (12.6%)	4044 (49.7%)	1261 (15.5%)	1815 (22.3%)	11.35 (0.253)	1249 (16.2%)	4687 (60.8%)	979 (12.7%)	794 (10.3%)	100.14 (<0.001)
	1 to 3 weeks	1331 (13.4%)	4879 (49.1%)	1530 (15.4%)	2186 (22.0%)		1743 (15.3%)	6776 (59.5%)	1481 (13.0%)	1389 (12.2%)	
	4 to 6 weeks	1545 (12.6%)	6132 (50.0%)	1901 (15.5%)	2686 (21.9%)		1951 (15.2%)	7600 (59.2%)	1849 (14.4%)	1451 (11.3%)	
	every day	2300 (12.9%)	9023 (50.6%)	1864 (15.2%)	3780 (21.2%)		2492 (17.3%)	8788 (61.0%)	1476 (11.5%)	1470 (10.2%)	
Soda	Less than once a week	1014 (13.3%)	3888 (51.0%)	1128 (14.8%)	1593 (20.9%)	30.48 (<0.001)	1948 (15.3%)	7765 (61.0%)	1617 (12.7%)	1400 (11.0%)	48.49 (<0.001)
	1 to 2 weeks	2743 (12.4%)	10,970 (49.6%)	3494 (15.8%)	4910 (22.2%)		3479 (15.5%)	13,446 (59.9%)	2963 (13.2%)	2537 (11.3%)	
	more than three times a week	2432 (13.2%)	8937 (48.5%)	2911 (15.8%)	4146 (22.5%)		2010 (18.0%)	6622 (59.3%)	1374 (12.3%)	1161 (10.4%)	
Fast food	Less than once a week	1177 (13.8%)	4513 (52.9%)	1271 (14.9%)	1570 (18.4%)	111.31 (<0.001)	1475 (15.2%)	5794 (59.7%)	1291 (13.3%)	1145 (11.8%)	50.71 (<0.001)
	1 to 2 weeks	3653 (12.5%)	14,494 (49.6%)	4529 (15.5%)	6546 (22.4%)		4346 (15.6%)	16,825 (60.4%)	3621 (13.0%)	3036 (10.9%)	
	more than three times a week	1354 (13.0%)	4978 (47.8%)	1614 (15.5%)	2468 (23.7%)		1598 (18.2%)	5225 (59.5%)	1045 (11.9%)	913 (10.4%)	
Eating behavior education	None	4188 (12.9%)	16,201 (49.9%)	4967 (15.3%)	7110 (21.9%)	1.48 (0.675)	5540 (16.1%)	20,680 (60.1%)	4473 (13.0%)	3716 (10.8%)	4.54 (0.191)
	Yes	2026 (12.9%)	7867 (50.1%)	2434 (15.5%)	3376 (21.5%)		1909 (16.0%)	7172 (60.1%)	4301 (12.5%)	1348 (11.3%)	
Total		n = 6087 (12.9%)	n = 23,350 (50.0%)	n = 7046 (15.4%)	n = 10,122 (21.8%)		n = 7173 (16.0%)	n = 26,845 (60.1%)	n = 5837 (12.9%)	n = 5022 (11.0%)	

4.3. Relationship between Physical Activity and Obesity in Youth

Table 4 shows the results of cross-analysis of complex samples and chi-square test to find out the degree of physical activity and the link between youth obesity. The physical activity factors consisted of the number of days of physical activity, number of days of physical exercise, hours of physical exercise per week, and the degree of stress recognition. First, the comparison of body types based on the number of days of physical activity showed that the group, which is about one to two times a week, had a highest obesity rate of 22.3% for boys and 12.6% for girls with three or more times a week. According to the number of days of physical exercise, 25% of male students have less than once a week, 22.3% of them have less than once a week, and 17.8% of those who exercise more than three times a week. For girls, there was a statistically significant difference, but the difference in obesity rates was extremely low. Comparative results of body types according to physical education hours confirmed that the obesity rate was lower for boys with more physical education hours per week, and for girls, only the same fine-grained difference was shown for girls with more muscle exercise days. Finally, the results of the comparison based on the degree of stress showed that the higher the rate of obesity in the group, regardless of gender, was higher.

4.4. Odds Ratio between Childhood Obesity and Influencing Factors

Odds ratio was conducted by selecting variables that showed significant differences among general characteristics, eating behavior, and physical activity. The results of identifying the odds ratio in the complex sample logistic regression to find estimates of relative risk for factors that showed significant differences in previous cross-analysis (soft drink intake, fast food intake frequency, school type, school grade, and academic performance) are as shown in Table 5. The variables used in the analysis were divided into groups of whether or not soft drinks were consumed for 1 week and whether fast food was consumed, and relative risk was measured based on groups that did not have experience in eating. The type of school measured Odds Ratio based on coeducation, first grade in high school, and top grade group in academic performance. As a result, the group ingests 1.158 times ($\chi^2 = 41.590$, $p < 0.001$) more than the group that does not consume soda, which shows a high probability of obesity, and fast food intake groups are 1.129 times ($\chi^2 = 25.325$, $p < 0.001$) more likely than those who do not consume fast food to be obese. In school types, students belonging to male or female schools are 1.230 times ($\chi^2 = 51.692$, $p < 0.001$) more likely than coeducational students to show a high probability of obesity. In the first year of high school, 1.150 times more students in the second grade and 1.263 times those in the third grade had a high probability of obesity, and the academic performance was 1.549 times ($\chi^2 = 185.603$, $p < 0.001$) that of students in the lower group based on upper group student standards, which showed a high probability of obesity.

Table 4. Relationship between Physical Activity and Obesity in Youth.

		Male (n = 48,168)					Female (n = 46,343)				
		Underweight	**Normal**	**Overweight**	**Obesity**	χ^2 **(*p*)**	**Underweight**	**Normal**	**Overweight**	**Obesity**	χ^2 **(*p*)**
Physical activity	Less than once a week	2006 (15.4%)	6266 (48.1%)	1928 (14.8%)	2827 (21.7%)	199.36 (<0.001)	3886 (16.9%)	13,910 (60.5%)	2851 (12.4%)	2345 (10.2%)	77.35 (<0.001)
	1 to 2 weeks	2226 (13.6%)	7970 (48.7%)	2520 (15.4%)	3649 (22.3%)		2547 (15.7%)	9652 (59.5%)	2141 (13.2%)	1882 (11.6%)	
	more than three times a week	1953 (10.4%)	9839 (52.4%)	2967 (15.8%)	3999 (21.3%)		977 (13.7%)	4299 (60.3%)	955 (13.4%)	898 (12.6%)	
Muscular exercise	Less than once a week	2415 (14.0%)	7917 (45.9%)	2587 (15.0%)	4312 (25.0%)	26.85 (<0.001)	5437 (16.6%)	19,555 (59.7%)	4160 (12.7%)	3570 (10.9%)	29.78 (<0.001)
	1 to 2 weeks	1923 (13.2%)	7064 (48.5%)	2330 (16.0%)	3248 (22.3%)		1380 (14.6%)	5727 (60.6%)	1266 (13.4%)	1077 (11.4%)	
	more than three times a week	1864 (11.4%)	9093 (55.6%)	2486 (15.2%)	2911 (17.8%)		614 (14.9%)	2565 (62.0%)	517 (12.5%)	439 (10.6%)	
PE class	Less than once a week	1083 (15.6%)	3228 (46.5%)	1000 (14.4%)	1631 (23.5%)	161.90 (<0.001)	1152 (16.6%)	4172 (60.1%)	875 (12.6%)	750 (10.8%)	23.18 (<0.001)
	once a week	1436 (13.0%)	5390 (48.8%)	1701 (15.4%)	2518 (22.8%)		1679 (15.2%)	6638 (60.1%)	1513 (13.7%)	1215 (11.0%)	
	twice a week	2541 (13.0%)	9772 (50.0%)	3010 (15.4%)	4221 (21.6%)		3225 (16.5%)	11,746 (60.1%)	2423 (12.4%)	2150 (11.0%)	
	more than three times a week	1138 (10.7%)	5702 (53.6%)	3107 (15.9%)	2096 (19.7%)		1638 (15.4%)	6393 (60.1%)	2502 (12.8%)	1245 (11.7%)	
Stress	upper	605 (13.7%)	2114 (47.9%)	662 (15.0%)	1033 (23.4%)	35.881 (<0.001)	1127 (16.2%)	3917 (56.3%)	953 (13.7%)	953 (13.7%)	138.27 (<0.001)
	mid-upper	1461 (12.8%)	5640 (49.4%)	1690 (14.8%)	2626 (23.0%)		2535 (15.5%)	9829 (60.1%)	2110 (12.9%)	1881 (11.5%)	
	middle	2757 (12.7%)	10,939 (50.4%)	3451 (15.9%)	4580 (21.1%)		2911 (16.0%)	11,154 (61.3%)	2329 (12.8%)	1801 (9.9%)	
	middle-low	1085 (12.9%)	4271 (50.8%)	3300 (15.2%)	1774 (21.1%)		723 (16.9%)	2640 (61.7%)	2184 (12.0%)	402 (9.4%)	
	low	302 (13.6%)	1114 (50.1%)	336 (15.1%)	471 (21.2%)		136 (24.4%)	297 (53.4%)	58 (10.4%)	66 (11.8%)	
Total		n = 6087 (12.9%)	n = 23,350 (50.0%)	n = 7046 (15.4%)	n = 10,122 (21.8%)		n = 7173 (16.0%)	n = 26,845 (60.1%)	n = 5837 (12.9%)	n = 5022 (11.0%)	

Table 5. Odds ratio between childhood obesity and influencing factors.

		Obesity			
		OR	**95% CI**	χ^2	p
Soda	None	1	-	41.590	<0.001
	Yes	1.158	1.108–1.211		
Fast food	None	1	-	25.325	<0.001
	Yes	1.129	1.077–1.183		
Type of School	coeducation	1	-	51.692	<0.001
	etc.	1.230	1.162–1.301		
Grade	1st	1	-	102.931	<0.001
	2nd	1.150	1.100–1.202		
	3rd	1.263	1.207–1.322		
Academic Performance	upper	1	-	185.603	<0.001
	mid-upper	1.156	1.079–1.237		
	middle	1.173	1.093–1.258		
	middle-low	1.401	1.305–1.504		
	low	1.549	1.432–1.675		

5. Discussion

The purpose of this study is to check the level of risk of obesity due to eating habits and physical activity factors of high school students in Korea. The second purpose is to utilize the results of the study as a basis for the research of programs for youth obesity and the development of educational programs in schools.

This research used raw data provided by the Korea Centers for Disease Control and prevention from the 12th to the 14th session of the KYRBS and analyzed the link between obesity, eating habits and physical activity among Korean high school students. The samples consisted of 48,168 male students (52.2%) and 46,343 female students (47.8%), with a total of 94,511 respondents being used for the analysis. The results of this study are as follows.

First, the link between youth obesity and general characteristics was verified and boys were 15.4% overweight and 21.8% obese in gender, while girls were divided into 12.9% overweight and 11.0% obese. The overall obesity rate was twice as high for boys as girls. According to the difference in body type between grades, the obesity rate increases for both males and females in higher grades. In particular, male students showed a greater increase than female students. The distribution of obese students in groups with relatively low grades was high. Comparing the differences between economic conditions, it was found that for male students the distribution of underweight and obese students fell in the lowest economic bracket; female students saw an increase in the proportion of underweight and obese students and an increase in the proportion of obesity in the lower economic conditions. Finally, the school type showed that the obesity rate is lower for coeducation students. In the case of coeducation, it can be interpreted that both male and female students are well managed by physical appearance such as physical appearance and body shape. This differed according to gender. However, all of them were found to be highly related to obesity, resulting in similar results to the Ahn, Park and Park's study results [44]. Also, the higher the grade, the higher the obesity rate and the higher the obesity rate in the lower academic performance. The results are consistent with Chung, Lee and Chung's study [45], and Cho's study [46].

Second, the link between eating behavior and youth obesity did not show any significant difference in the frequency of breakfast for boys, but there was a significant difference for girls. It was analyzed that the percentage of overweight and obese people in groups that do not eat breakfast at all and those who eat daily was slightly lower. The same result was found in Jeon and Hwang [47], which can be judged to be less related to obesity and the frequency of breakfast. According to the frequency of soft drink and fast food intake, male students had higher obesity rates in the group. On the other hand,

female students showed statistically significant differences, but they were judged to be somewhat lacking in interpreting the link between frequency of intake and obesity. Studies by Cho [46], and Kim and Lee [48] show that the higher the intake frequency of soda and fast food, the higher the obesity rate. However, this study produced different results. The results are believed to be different from the previous research because this data examined the diet within a week. In addition, a comparison of body shapes based on nutrition and diet education did not show significant differences between groups with and without training experience. Considering that the obesity rate of middle school students with nutrition and eating behavior is about 2% lower, it shows that high school students lack the effectiveness of their diet education.

Third, after verifying the link between physical activity level and youth obesity, the group which is one to two times a week for boys was the highest with 22.3% for boys, and 12.6% for girls who are more than three times a week, according to the number of days of physical activity. According to the number of days of physical exercise, boys tend to have lower obesity rates as they exercise more, while girls showed a statistically significant difference in obesity rates. According to physical education class, male students found that obesity rate was lower in group that had more physical education time, and female students did not see much difference. Finally, the results of the comparison based on the degree of stress showed that the higher the rate of obesity in the group, regardless of gender, was higher. If you look at the previous study on physical activity and obesity, a study by Yoon [42] found that teenagers who are actually doing physical activities through physical education classes at school more than three times a week were less obese than those who were not. Therefore, the results were similar to this study.

Finally, checking the odds ratio to find out the relative risk estimates of the impact of each factor on obesity showed that groups that consume more soda are 1.158 times more likely to be obese, and fast food intake groups are 1.129 times more likely to be obese than those that do not. In the school type, students belonging to male or female schools had a 1.230 times higher obesity rate than coeducation students Second-grade students were 1.150 times more likely to be obese than first-year high school students, and third-grade students were 1.263 times more likely to be obese. In terms of academic performance, lower group students had a 1.549 times higher obesity rate than upper group students. This study implicates that first, these results will be the basic data for youth eating behavior and nutrition education by identifying factors on childhood obesity and verifying obesity risks. It is also of academic value as it will be used to raise the awareness of the risk of youth obesity and to develop obesity mediation programs in schools.

Second, based on the results of a comparison between general characteristics and obesity, obesity management should be focused on seniors, underperforming, and low income. Especially for high school students, most of their time is spent at school during the day, so they should focus on health care as well as on studying. In addition, policies for physical education classes and school sports club activities should be prepared to take account of the economically vulnerable. This will help ease inequalities in health behavior due to the economic environment of low-income teenagers and help promote physical and mental health of teenagers.

Third, it is deemed that the result of the lack of significant differences in obesity rates, depending on whether nutrition and eating behavior are being educated, is a failure of education. Therefore, schools should continue to educate students about their differentiated eating habits and nutrition education according to their physical constitution. Furthermore, the government needs a lot of support in research and development of youth obesity arbitration programs.

Fourth, the higher the frequency of physical education, the lower the obesity rate in comparison with the obesity rate according to the degree of physical activity and the greater the difference to other physical activity factors. Therefore, it is believed that the improvement of athletic and physical education programs will have the greatest effect in adolescence. Especially in high school, the focus is on college entrance, which reduces the portion of physical education subjects and also reduces student participation [49]. Therefore, schools, parents and students should all be aware of the importance of

physical education and ensure that proper physical education activities can be implemented. Also, in previous studies, obese students have a negative perception of physical education compared to normal weight students. Physical education class satisfaction was also found to be low. In order to actively engage obese students in physical education classes, it was suggested that the teaching methods and content for obese students should be provided [50]. Therefore, it is believed that the physical activity of teenagers can be increased effectively if overweight students can develop active physical activity and develop regular habits through physical education.

Fifth, there are differences in body characteristics and eating habits depending on gender. Therefore, the relationship between obesity and students was analyzed by dividing them into boys and girls. As a result, boys' and girls' groups were able to see differences in their relationship to obesity. In addition, the difference in obesity rates was shown to be significant, depending on the general characteristics. Based on these results, the obesity arbitration program in schools will have to be developed in consideration of gender, school type, academic performance, and economic status. Also, as the academic year increases, the likelihood of obesity increases. Therefore, it is believed that as they move up to higher grades, students need more guidance from teachers and parents for weight control.

Finally, there are limitations in cross-sectional studies to identify causal relationships using raw data from the KYRBS. In addition, the BMI was used to simply divide the weight by the square of the height. The BMI is believed to be a reference value for obesity, which does not take into account bone density, body fat rate and muscle mass, and will be a factor that will undermine confidence and validity. Therefore, quantitative research will be needed using data from physical measurement factors such as muscle mass, and basic data for such quantitative research is thought to be urgent. The other limitation is with regard to the index for categories of physical activity and dietary behavior, all indices are limited because they have a reference period of the past 7 days.

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