

ASSOCIATION BETWEEN OVERWEIGHT/OBESITY AND ACADEMIC PERFORMANCE IN SOUTH KOREAN ADOLESCENTS

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SUMMARY

The purpose of this study was to examine the relationship between academic performance and obesity/overweight among South Korean adolescents. Our data set included 72,399 adolescents in grades 7–12 who had participated in the 5th Korea Youth Risk Behaviour Web-based Survey (KYRBWS-V) in 2009. We assessed the association between academic performance and body mass index (BMI), using multivariate logistic regression analysis after adjusting for covariates such as age, parents' education level, economic status, mental stress experienced, sleep duration, frequency of muscle-strengthening exercises, smoking and drinking behaviour, and vigorous and moderate physical activity (PA). For boys, being overweight (compared with being of normal weight) had a significantly greater odds of poor academic performance (OR=1.182, 95% CI 1.052–1.329, $p=0.005$). Obese boys had 1.182 (1.048–1.332, $p=0.006$), 1.461 (1.294–1.648, $p<0.001$), and 1.443 (1.256–1.657, $p<0.001$) greater odds of having average, poor, and very poor performance, respectively. In the analysis for girls, overweight girls had 1.314 (1.124–1.536, $p<0.001$) and 1.296 (1.084–1.548, $p=0.004$) greater odds of having poor and very poor academic performance, respectively. Finally, obese girls had 1.374 (1.098–1.718, $p=0.005$), 1.672 (1.339–2.089, $p<0.001$), and 1.887 (1.478–2.409, $p<0.001$) greater odds of having average, poor, or very poor academic performance, respectively. Thus, overweight/obesity was negatively associated with academic performance in both boys and girls. The results of this study indicate that adolescents would benefit from weight management to prevent obesity and, possibly, improve academic performance.

Key words: academic performance, adolescent, obesity

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INTRODUCTION

In the United States, according to the Centers for Disease Control and Prevention (CDC), approximately 17% (i.e. 12.5 million) of children and adolescents aged 2–19 years are obese, with the obesity prevalence in these groups having almost tripled since 1980 (1). Because obesity is known to be a major risk factor for diseases such as type-II diabetes, hypertension, stroke, cardiovascular disease, musculoskeletal disorders, and cancer, it has become a major social and public health concern worldwide (1).

According to the 4th Korea National Health and Nutrition Examination Survey (KNHANES-IV), 31.3% of adults aged 19 years or older in South Korea are obese, as compared to 33.8% of adults in the United States. Furthermore, 11.3% of adolescents aged 12–18 years in South Korea are obese, as compared to approximately 17% of their counterparts in the United States. However, research indicates that the prevalence of obesity is steadily increasing with every year (1–2).

Excess weight status is related to race, gender, socioeconomic status, culture, genetics, physical inactivity, mass media use (e.g. excessive TV viewing), and fast food intake (3–4). Therefore, many studies have investigated the possibility of preventing or treating obesity by addressing its major risk factors, such as low physical activity (PA) and sedentary behaviour (5–7).

Interestingly, obesity might also be associated with reduced cognitive capabilities and memory functions (8–13). Indeed, a high body mass index (BMI) has been linked with negative alterations in brain structure and an increased risk of Alzheimer's disease (14–15).

Academic performance is generally considered related to cognitive and memory functions (16). Given the negative association of obesity with cognitive and memory functions (8–15), being overweight/obesity might have a negative influence on the academic achievement of adolescents. However, epidemiological evidence regarding the association between being overweight/obesity and adolescents' academic performance is lacking. Therefore, the purpose of this study was to examine whether being overweight/obesity was related to academic performance among adolescent South Korean students.

MATERIALS AND METHODS

Subjects

In order to evaluate the relationship between being overweight/obesity and the academic performance of adolescents, we utilized data from the 5th Korea Youth Risk Behaviour Web-based Survey (KYRBWS-V), conducted in 2009. This was a cross-sectional

epidemiological study that collected data from 135 strata identified using stratified multistage cluster sampling. Each stratum consisted of 400 of middle and high schools (primary sampling units), and over 24,000 classrooms (secondary sampling units). The study used a cluster sampling strategy that led to the selection of 16 cities with a sampling frame that included all parts of South Korea. Potential covariate variables were taken into account (17). KYRBWS-V was conducted by the Korea Centers for Disease Control and Prevention (KCDCP) to estimate the prevalence of health risk behaviours among South Korean adolescents in grades 7 to 12 (17). All the details pertaining to the data collection procedures are reported elsewhere (17). KYRBWS-V is considered valid and reliable (18–19), and was administered to a nationally representative group; further, because private information was not collected for KYRBWS-V, ethical approval was not required for the study.

For the present study, data were obtained from KYRBWS-V to evaluate the association between academic performance and being overweight/obesity, taking into account potential covariates such as age, parents' education level, economic status, mental stress experienced, sleep duration, frequency of muscle-strengthening exercises, smoking and drinking behaviour, and vigorous and moderate PA.

For participation in KYRBWS-V, teachers allocated the unique identification number to each participating student, which granted the students access to the survey web page. Once logged onto the web page, the students were first asked about their willingness to participate in the survey. Willing students were given access to a self-administered questionnaire, which they completed anonymously at school. Those who were unwilling to participate did not proceed further.

The response rate for KYRBWS-V was 97.6% ($N=75,066/76,937$); however, 2,667 were excluded because they had been from school for long periods or had dyslexia or dysgraphia; thus, the final sample usable for our study purposes was 72,399 students. The characteristics of the subjects are shown in Table 1.

Dependent Variables

The students were asked to indicate their height and weight measurements on KYRBWS-V, from which we calculated their respective BMIs (kg/m^2). Adopting the World Health Organization Asia-Pacific standard of obesity, subjects with BMI of less than $23 \text{ kg}/\text{m}^2$, between 23 and $25 \text{ kg}/\text{m}^2$, and over $25 \text{ kg}/\text{m}^2$ were classified as normal, overweight, and obese, respectively (20).

Table 1. The characteristics of subjects: mean \pm standard deviation or number (%)

Variables		Boys (n=38,152)	Girls (n=34,247)	Total (n=72,399)
Age (years)		15.0 \pm 1.7	15.1 \pm 1.8	15.1 \pm 1.8
Height (cm)		169.6 \pm 8.2	160.1 \pm 5.4	165.1 \pm 8.5
Weight (kg)		60.1 \pm 11.7	51.5 \pm 7.7	56.0 \pm 10.9
Body mass index (kg/m^2)		20.8 \pm 3.2	20.1 \pm 2.6	20.5 \pm 3.0
Weight state N (%)	Normal weight (BMI<23)	29,404 (77.1)	29,674 (86.6)	59,078 (81.6)
	Over weight (23≤BMI<25)	4,385 (11.5)	2,961 (8.7)	7,346 (10.2)
	Obese (25≥BMI)	4,363 (11.4)	1,612 (4.7)	5,975 (8.3)
City size N (%)	Large cities	20,252 (53.1)	17,708 (51.7)	37,960 (52.4)
	Middle-sized cities	13,303 (34.9)	12,153 (35.5)	25,456 (35.2)
	Small-sized cities	4,597 (12.0)	4,386 (12.8)	8,983 (12.4)
Academic performance N (%)	Very good	4,738 (12.4)	3,349 (9.8)	8,087 (11.2)
	Good	8,945 (23.5)	8,218 (24.0)	17,163 (23.7)
	Average	10,237 (26.8)	9,413 (27.5)	19,650 (27.1)
	Poor	9,324 (24.4)	9,141 (26.7)	18,465 (25.5)
	Very poor	4,908 (12.9)	4,126 (12.0)	9,034 (12.5)
Economic status N (%)	Very rich	2,691 (7.1)	1,337 (3.9)	4,028 (5.6)
	Rich	8,768 (23.0)	6,719 (19.6)	15,487 (21.4)
	Average	17,229 (45.2)	17,259 (50.4)	34,488 (47.6)
	Poor	6,890 (18.1)	6,825 (19.9)	13,715 (18.9)
	Very poor	2,574 (6.7)	2,107 (6.2)	4,681 (6.5)
Grade N (%)	7th	6,711 (17.6)	5,615 (16.4)	12,326 (17.0)
	8th	6,722 (17.6)	5,727 (16.7)	12,449 (17.2)
	9th	6,767 (17.7)	5,615 (16.4)	12,382 (17.1)
	10th	6,626 (17.4)	5,369 (15.7)	11,995 (16.6)
	11th	5,889 (15.4)	6,102 (17.8)	11,991 (16.6)
	12th	5,437 (14.3)	5,819 (17.0)	11,256 (15.5)

Independent Variables

Each participant's self-reported academic performance was evaluated through one question: (Q1) "In the past 12 months, how has your average academic performance been?" The available responses were as follows: 1 – very good, 2 – good, 3 – average, 4 – poor, and 5 – very poor.

Covariate Variables

- 1) The age reported by students on the KYRBWS-V data was used without any modification.
- 2) Parents' education level: Response choices were organized into a 3-point Likert-type scale (1 = middle school or lower, 3 = college or higher).
- 3) Economic status: Response choices were organized into a 5-point Likert-type scale (1 = very wealthy, 5 = very poor).
- 4) Mental stress experienced: Response choices were organized into a 5-point Likert-type scale (1 = none, 5 = very high).
- 5) Sleep duration: Responses were organized into a 6-point Likert-type scale (1 ≤ 4 h/day, 6 ≥ 8 h/day).
- 6) Frequency of muscle-strengthening exercises such as sit-ups, push-ups, and weight lifting or weight training during the week: Response choices were organized into a 6-point Likert-type scale (1 = never, 6 = more than five days).
- 7) Smoking behaviour (frequency of smoking): Response choices were organized into a 7-point Likert-type scale (1 = never, 7 = every day).
- 8) Drinking behaviour (frequency of drinking): Response choices were organized into a 7-point Likert-type scale (1 = never, 7 = every day).
- 9) Frequency of vigorous PA such as digging, aerobics, heavy lifting, and fast cycling during the week: Response choices were organized into a 6-point Likert-type scale (1 = never, 6 = more than five days).
- 10) Frequency of moderate PA such as bicycling at a regular pace, carrying light loads, and playing doubles tennis during the week: Response choices were organized into a 6-point Likert-type scale (1 = never, 6 = more than five days).

Statistical Analyses

All results from this study are presented as means ± standard deviations. Multivariate logistic regression analyses were conducted to determine whether the academic performance of participating adolescents was associated with being overweight/obesity, after adjusting for confounding variables. Statistical significance was set at $p < 0.05$, and all analyses were performed using SPSS Complex Sample™ version 18.0 (SPSS, Chicago, IL, USA).

RESULTS

Tables 2 and 3 show results of the multivariate logistic regression analyses. These depict a comparison between overweight adolescents and those of normal weight as well as obese adolescents and those of normal weight, according to self-reported academic performance. In addition, the tables show the prevalence of obesity and being overweight, or of normal weight, among the South Korean adolescents in our sample. Scores on academic performance ranged from 1 (very good) to 5 (very poor) after adjustment for covariate variables. Covariate variables were specified as age, parents' education level, economic status, mental stress experienced, sleep duration, frequency of muscle-strengthening exercises, smoking and drinking behaviour as well as vigorous and moderate PA.

Overweight boys (as compared to those being of normal weight) had 1.182 (1.052–1.329, $p = 0.005$) greater odds of poor academic performance (Table 2). In addition, for this group, obesity had 1.182 (1.048–1.332, $p = 0.006$), 1.461 (1.294–1.648, $p < 0.001$), and 1.443 (1.256–1.657, $p < 0.001$) greater odds of average, poor, and very poor academic performance, respectively (Table 3).

Overweight girls (as compared to those being of normal weight) had 1.314 (1.124–1.536, $p < 0.001$) and 1.296 (1.084–1.548, $p = 0.004$) greater odds of poor and very poor academic performance, respectively (Table 2). Furthermore, for this group, obesity (as compared with being of normal weight) had 1.374 (1.098–1.718, $p = 0.005$), 1.672 (1.339–2.089, $p < 0.001$), and 1.887 (1.478–2.409, $p < 0.001$) greater odds of average, poor, and very poor academic performance (Table 3).

Table 2. The multivariable logistic regression analysis of academic performance for the overweight and normal-weight groups in Korean adolescents

Academic performance		Overweight vs. normal-weight					
		Case	β	SE	OR	95% CI	p-value
Boys	Very good	4,262	Reference		1.000		
	Good	7,985	0.058	0.058	1.059	0.945–1.187	0.320
	Average	9,104	0.053	0.058	1.054	0.941–1.182	0.364
	Poor	8,138	0.167	0.060	1.182	1.052–1.329	0.005**
	Very poor	4,300	0.008	0.071	1.009	0.877–1.160	0.905
Girls	Very good	3,242	Reference		1.000		
	Good	7,890	0.123	0.080	1.131	0.967–1.322	0.123
	Average	8,987	0.107	0.080	1.112	0.952–1.300	0.181
	Poor	8,645	0.273	0.080	1.314	1.124–1.536	<0.001***
	Very poor	3,871	0.259	0.091	1.296	1.084–1.548	0.004**

$p < 0.01$ **, $p < 0.001$ ***; tested by the multivariable logistic regression analysis adjusting for covariate variables such as age, parents' education level, economic status, mental stress experienced, sleep duration, frequency of muscle-strengthening exercises, smoking and drinking behaviour, and vigorous and moderate physical activity

Table 3. The multivariable logistic regression analysis of academic performance for the obesity and normal-weight groups in Korean adolescents

Academic performance		Obesity vs. normal-weight					
		Case	β	SE	OR	95% CI	p-value
Boys	Very good	4,187	Reference		1.000		
	Good	7,876	0.104	0.061	1.109	0.983–1.251	0.092
	Average	9,069	0.167	0.061	1.182	1.048–1.332	0.006**
	Poor	8,222	0.379	0.062	1.461	1.294–1.648	<0.001***
	Very poor	4,413	0.367	0.071	1.443	1.256–1.657	<0.001***
Girls	Very good	3,109	Reference		1.000		
	Good	7,537	0.212	0.116	1.236	0.986–1.550	0.066
	Average	8,629	0.317	0.114	1.374	1.098–1.718	0.005**
	Poor	8,272	0.514	0.114	1.672	1.339–2.089	<0.001***
	Very poor	3,739	0.635	0.125	1.887	1.478–2.409	<0.001***

p<0.01**, p<0.001***; tested by multivariable logistic regression analysis adjusting for covariate variables such as age, parents' education level, economic status, mental stress experienced, sleep duration, frequency of muscle-strengthening exercises, smoking and drinking behaviour, and vigorous and moderate physical activity

DISCUSSION

The aim of this study was to investigate the association between being overweight/obesity and academic performance among South Korean adolescents. The results showed significant associations between being overweight and poor academic performance as well as obesity and poor academic performance among both boys and girls despite adjustment for obesity-related covariates.

Many epidemiological studies have shown an association between high BMI and poor performance on cognitive tasks related to physiological functioning, memory and language (8–13). The precise reason for this finding is still unclear, as are the mechanisms underlying cognitive disorders that are related to being overweight. However, Gray et al. (2006) reported that obesity appears to negatively affect brain-derived neurotrophic factor (BDNF), neurotrophin known to play a role in the development and maturation of neurons in brain regions other than the hippocampus; thus, in general, BDNF haploinsufficiency is likely to be associated with cognitive dysfunction, including intellectual impairments as well as language, numeracy, attention, and memory deficits (21–22). Nevertheless, our results also support previous findings indicating an association between being overweight/obesity and poor cognitive outcomes (e.g. academic performance).

Academic performance may have a strong association with reading, speaking, and writing abilities as well as comprehension. These may have bearing on, among others, mathematical ability. In turn, these functions are related to brain activity and functioning (16, 23). Even though our study shows a relationship between being overweight/obese and academic performance at an epidemiological level, the interrelationships observed in this study were relatively weak (OR=1.182–1.887, p<0.05), when one considers the large sample size. In general, adolescence is a phase involving rapid physical growth accompanied by the development of various psychological and neural abilities. Needless to say, these changes also apply to obese adolescents (24). We attribute the weak associations between weight status and academic performance found among adolescents in the current study to the fact that brain activity is higher in adolescence than in

adulthood. Nevertheless, future studies should adopt more suitable designs in order to determine the extent to which variables such as diet, eating patterns and covariates such as sleep duration affect academic performance among Korean adolescents.

Several limitations were identified in this study. First, KYR-BWS-V was conducted online; therefore, parents' education levels and economic status were recorded by the students. Furthermore, KYRBWS-V assessed the academic performance of adolescents using self-reports, rather than objective measures. Therefore, even though the reliability and validity of KYRBWS-V have been confirmed (17–19), the data that we obtained may be inaccurate. Second, the students also reported their height and weight measurements online; these variables were not directly measured. In view of this, the proportion of students who are overweight/obese may, in fact, be higher, since adolescents tend to overestimate their height and underestimate their weight (25). Third, this was a retrospective epidemiological study. As a result, we did not examine causal relationships, only assessing the associations between academic performance and being overweight/obesity instead. Nevertheless, because our sample comprised 72,399 students from all parts of South Korea and was, thus, highly representative of the Korean adolescent population, the relationship we found can be generalized to all South Korean adolescents.

CONCLUSION

Being overweight/obese had a negative association with academic performance among both boys and girls in South Korea. From these results, there is a clear need for adolescent students to control their weight so as to prevent obesity. This may, in turn, improve their academic performance.

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Conflict of Interests

None declared

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