Association between Physical Inactivity and Academic Record in Korean Adolescents

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Abstract

Background: The purpose of this study was to investigate the association between physical inactivity and academic record in Korean adolescents.

Methods: Adolescent students from the first grade of middle school to the third grade of high school (n=75,066) participated in the 5th Korea Youth Risk Behavior Web-based Survey project in 2009. The association between physical inactivity and academic record was assessed using multivariate logistic regression analysis after adjusting for gender, age, body mass index, family's socioeconomic status, parents' education level, and frequency of vigorous or moderate physical activity (PA) as well as muscular strength exercises.

Results: During weekdays, the odds ratios (ORs) (95% confidence interval [CI]) for reporting a higher than average academic record, as compared with <1 hour of physical inactivity per day, was 0.796 (0.761–0.832, for ≥1 to <2 hours, 0.632 (0.603–0.663, for ≥2 to <3 hours, 0.567 (0.535–0.601, for ≥3 to <4 hours, and 0.494 (0.468–0.522, $P <$ 0.001 for all cases) for ≥4 hours of physical inactivity per day. During the weekends, the ORs (95% CI) for reporting a higher than average academic record, as compared with <1 hour of physical inactivity per day, were 0.901 (0.848–0.957, $P =$ 0.001) for ≥3 to <4 hours and 0.785 (0.743–0.830, $P <$ 0.001) for ≥4 hours of physical inactivity per day.

Conclusion: Korean adolescents who spend more time engaged in physical inactivity are predisposed to a below-average academic record.

Keywords: Adolescent, Korea Youth Risk Behavior Web-based Survey-V, Physical inactivity, Academic record

Introduction

Adolescence is an important period with regard to establishing a healthy life-style (1). For example, approximately 80% of obese children remain obese even as adults (2). Hence, many studies have investigated adolescents' life-styles and the establishment of healthy habits such as increasing physical activity (PA) and decreasing sedentary activities (3-7).

Physical inactivity (sedentary activity) has adverse health effects such as increased risk for cardiac diseases, musculoskeletal disorders, stroke, type 2 diabetes, weight gain, and some cancers (3-6). Conversely, physical activity, a variable that is

independent of inactivity, has health benefits such as improved weight control, bone and muscle strength, mental health and mood, ability to perform daily activities, and life span; moreover, the risk for cardiovascular diseases, type 2 diabetes, metabolic syndromes, some cancers, and falls is reduced (7).

Recently, several studies have shown that PA improves brain activities, including memory and cognitive functions (8-10). Subsequent studies suggest that adequate PA improves school performance and academic achievements of adolescent students (11,12). Though PA and its positive ef-

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fects on academic activities through increased brain activity has been studied extensively, whether sedentary activity and physical inactivity is associated with academic outcomes has not been a research focus. Furthermore, there is no epidemiological research involving clinical practice investigating the relationship between physical inactivity and academic record.

Therefore, the purpose of this study was to examine whether physical inactivity is associated with academic record in Korean adolescent students.

Materials and Methods

Subjects

In 2009, the 5th Korea Youth Risk Behavior Web-based Survey (KYRBWS-V) was conducted as an epidemiological study with a complex sample design including multistage sampling, stratification, and clustering through the Korea Centers for Disease Control and Prevention (KCDCP) to determine the prevalence of health-risk behaviors in Korean adolescent students from the 7th to the 12th grades (13).

The KYRBWS-V collected data from 24,000 classrooms (secondary sampling units) in 400 middle schools and 400 high schools (primary sampling units) and from 135 strata identified using a stratified multistage cluster sampling method. A 16-city cluster sampling strategy was utilized and the survey-sampling frame included all of Korea in order to evaluate the relationship between physical inactivity and academic records of adolescent students; potential covariate variables were taken into account (13). All details pertaining to the data collection procedures have been reported by the KCDCP, and the reliability and validity of the KYRBWS-V have been evaluated (13-15).

Students participating in the survey were assigned unique identification (ID) numbers by their classroom teachers. The students then accessed the survey's Internet webpage, logged on using their unique ID numbers, and responded to a question regarding their willingness to participate. Willing participants self-administered the questionnaire anonymously at their school, and those who were unwilling did not progress further. In total, there were 76,937 willing participants. However, students who had dyslexia, dysgraphia, or who were absent from school for an extended period were excluded. After the exclusions, 75,066 adolescent students participated in this study (the participation rate was 97.6%). Ethical approval was not required for this study because KYRBWS-V did not collect any personal information such as the students' names, their school, home address, residential area, telephone number, or social security number.

The present study obtained data from the KYRBWS-V to evaluate the relationship between physical inactivity and academic record, taking into account covariate variables such as gender, age, body mass index (BMI), family's socioeconomic status, parents' education level, and frequency of vigorous and moderate PA as well as muscular strength exercises. The characteristics of the subjects are shown in Table 1.

Independent variables

Physical inactivity was evaluated for each participant on the basis of their responses to the following 2 questions: (Q1) "In the last week, how much time, on average, did you spend per day on weekdays engaged in physical inactivity such as watching TV or movies, surfing the internet, and playing video games?" and (Q2) "In the last week, how much time, on average, did you spend per day on the weekend engaged in physical inactivity such as TV or movie watching, Internet surfing, video gaming, etc.?." The response options were: (i) <1 hour per day, (ii) ≥1 to <2 hours, (iii) ≥2 to <3 hours, (iv) ≥3 to <4 hours, and (v) ≥4 hours.

Dependent variables

Self-reported academic record was evaluated for each participant by asking the question, "In the past 12 months, what was your average academic record?". The response options were: (i) very high, (ii) high, (iii) average, (iv) low, and (v) very low. Based on these responses, the participants were then classified into the following 2 groups for multivariate logistic regression analyses: (i) <average academic record and (ii) ≥average academic record.

Table 1: The characteristics of the subjects

Variable		Boys (*n* = 39,612)	Girls (*n* = 35,454)	Total (*n* = 75,066)
Age (yr)		15.00 ± 1.73	15.12 ± 1.77	15.06 ± 1.75
Height (cm)		169.58 ± 8.19	160.08 ± 5.39	165.09 ± 8.46
Weight (kg)		60.14 ± 11.72	51.47 ± 7.67	56.04 ± 10.91
Body mass index (kg/m^2)		20.80 ± 3.21	20.05 ± 2.58	20.45 ± 2.95
Family's socioeconomic status, N (%)	Very rich	2,923 (7.4)	1,434 (4.0)	4,357 (5.8)
	Rich	8,985 (22.7)	6,908 (19.6)	15,893 (21.2)
	Average	17,743 (44.7)	17,706 (49.9)	35,449 (47.2)
	Poor	7,150 (18.1)	7,090 (20.0)	14,240 (19.0)
	Very poor	2,811 (7.1)	2,316 (6.5)	5,127 (6.8)
Father's education level N (%)	Unknown	7,297 (18.4)	5,321 (15.0)	12,618 (16.8)
	Middle school or lower	2,707 (6.8)	2,483 (7.0)	5,190 (6.9)
	High school	14,294 (36.1)	13,915 (39.2)	28,209 (37.6)
	College or higher	15,314 (38.7)	13,735 (38.8)	29,049 (38.7)
Mother's education level N (%)	Unknown	8,069 (20.4)	5,059 (14.3)	13,128 (17.5)
	Middle school or lower	2,447 (6.2)	2,490 (7.0)	4,937 (6.6)
	High school	17,745 (44.7)	18,212 (51.4)	35,957 (47.9)
	College or higher	11,351 (28.7)	9,693 (27.3)	21,044 (28.0)
Academic record N (%)	Very high	4,958 (12.5)	3,454 (9.7)	8,412 (11.2)
	High	9,172 (23.2)	8,411 (23.7)	17,583 (23.4)
	Average	10,544 (26.6)	9,675 (27.3)	20,219 (26.9)
	Low	9,661 (24.4)	9,477 (26.7)	19,138 (25.5)
	Very low	5,277 (13.3)	4,437 (12.5)	9,714 (12.9)
Sedentary lifestyle during weekdays N (%)	<1 hour per day	9,748 (24.6)	8,948 (25.2)	18,696 (24.9)
	≥1 to <2 hours per day	11,661 (29.4)	10,084 (28.4)	21,745 (29.0)
	≥2 to <3 hours per day	8,852 (22.3)	7,437 (21.0)	16,289 (21.7)
	≥3 to <4 hours per day	4,159 (10.5)	3,888 (11.0)	8,047 (10.7)
	≥4 hours per day	5,192 (13.1)	5,097 (14.4)	10,289 (13.7)
Sedentary lifestyle during the weekend N (%)	<1 hour per day	4,662 (11.8)	4,304 (12.1)	8,966 (11.9)
	≥1 to <2 hours per day	7,536 (19.0)	6,463 (18.2)	13,999 (18.6)
	≥2 to <3 hours per day	9,432 (23.8)	7,937 (22.4)	17,369 (23.1)
	≥3 to <4 hours per day	6,640 (16.8)	6,262 (17.7)	12,902 (17.2)
	≥4 hours per day	11,342 (28.6)	10,488 (29.6)	21,830 (29.1)
Grade N (%)	7th grade	6,933 (17.5)	5,781 (16.3)	12,714 (16.9)
	8th grade	6,965 (17.6)	5,903 (16.6)	12,868 (17.1)
	9th grade	7,035 (17.7)	5,792 (16.3)	12,827 (17.1)
	10th grade	6,890 (17.4)	5,587 (15.8)	12,477 (16.6)
	11th grade	6,104 (15.4)	6,323 (17.9)	12,427 (16.6)
	12th grade	5,685 (14.4)	6,068 (17.1)	11,753 (15.7)

Data are presented as mean ± SD or N (%)

Covariate variables

Gender

The 2 response options were (i) male and (ii) female.

Age

The adolescents' ages as per the KYRBWS-V were used without any modifications.

BMI

The adolescents were asked to self-record their height and weight; BMI (kg/m^2) was calculated from the raw data recorded by each participant.

Family's socioeconomic status

The 5 response options were: (i) very rich, (ii) rich, (iii) average, (iv) poor, and (v) very poor.

Parents' education level

The 4 response options were: (i) unknown, (ii) middle school or lower, (iii) high school, and (iv) college or higher.

Frequency of vigorous PA such as digging, aerobics, heavy lifting, and fast cycling during the week

The 6 response options were: (i) none, (ii) once, (iii) 2 times, (iv) 3 times, (iv) 4 times, and (vi) 5 times or more per week.

Frequency of moderate PA such as cycling at a regular pace, carrying light loads, and playing doubles tennis during the week

The 6 response options were: (i) none, (ii) once, (iii) 2 times, (iv) 3 times, (v) 4 times, and (vi) 5 times or more per week.

Frequency of muscular strength exercises such as sit-ups, push-ups, and weight lifting or weight training during the week

The 6 response options were: (i) none, (ii) once, (iii) 2 times, (iv) 3 times, (v) 4 times, and (vi) 5 times or more per week.

Statistical analysis

All results are presented as the mean ± standard deviation. Multivariate logistic regression analyses were conducted to determine whether the amount of physical inactivity was associated with academic record after adjusting for covariate variables. Statistical significance was set at $P < 0.05$, and all analyses were performed using SPSS ver. 18.0 (SPSS, Chicago, IL, USA).

Results

The results of the multivariate logistic regression analyses of the duration of physical inactivity per day for the <average academic performance and ≥average academic performance groups of Korean adolescents are shown in Table 2. This table compares the Korean adolescents belonging to these 2 groups with respect to the information on duration of physical inactivity per day that was provided (ranging from [1] <1 hour to [5] ≥4 hours).

Table 2: The multivariate logistic regression analyses of physical inactivity time per day for the <average academic record and ≥average academic record groups of Korean adolescents

Category	<average academic record vs. ≥average academic record									
	During weekdays					During weekend				
	Beta	S. E.	OR	95% CI	P-value	Beta	S. E.	OR	95% CI	P-value
<1 hour per day	Ref					Ref				
≥1 to <2 hours per day	-0.228	0.023	0.796	0.761-0.832	<0.001***	0.002	0.031	1.002	0.944-1.064	0.951
≥2 to <3 hours per day	-0.459	0.024	0.632	0.603-0.663	<0.001***	-0.004	0.029	0.996	0.940-1.055	0.882
≥3 to <4 hours per day	-0.567	0.030	0.567	0.535-0.601	<0.001***	-0.105	0.031	0.901	0.848-0.957	0.001**
≥4 hours per day	-0.705	0.027	0.494	0.468-0.522	<0.001***	-0.242	0.028	0.785	0.743-0.830	<0.001***

S.E.; Standard error, OR; Odds ratio, CI; Confidence interval

*** $P < 0.001$, tested by multivariate logistic regression analysis after adjustment for gender, age, body mass index, family's socioeconomic status, parents' education level, and frequency of vigorous or moderate physical activity (PA) as well as muscular strength exercises

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During weekdays, the odds ratios (OR) (95% confidence interval [CI]) for reporting a higher than average academic record, as compared with <1 hour of physical inactivity per day, was 0.796 (0.761–0.832, for ≥1 to <2 hours, 0.632 (0.603–0.663, for ≥2 to <3 hours, 0.567 (0.535–0.601, for ≥3 to 4 hours, and 0.494 (0.468–0.522) for ≥4 hours of physical inactivity per day. The results show that, during weekdays, among those reporting a higher than average academic record, the number of participants with ≥1 to <2 hours, ≥2 to <3 hours, ≥3 to <4 hours, and ≥4 hours of physical inactivity per day decreased by 20.4%, 36.8%, 43.3%, and 50.6%, respectively, as compared to the number of participants reporting <1 hour of physical inactivity per day.

During the weekend, the ORs (95% CI) for reporting a higher than average academic record, as compared to <1 hour of physical inactivity per day, was 0.901 (0.848–0.957, $P = 0.001$) for ≥3 to <4 hours and 0.785 (0.743–0.830, $P < 0.001$) for >4 hours of physical inactivity per day. The results show that during the weekend, among those reporting a higher than average academic record, the number participants with ≥3 to <4 hours and ≥4 hours of physical inactivity per day decreased by 9.9% and 21.5%, respectively, as compared to the number of participants reporting <1 hour of physical inactivity per day.

Discussion

The aim of this study was to examine the relationship between the duration of physical inactivity and a higher than average academic record in Korean adolescents. The results show that a higher than average academic record was negatively associated with increased duration of physical inactivity. Previous studies have reported that physical inactivity is strongly associated with obesity (16,17). Furthermore, other studies have reported that obesity is associated with decreased brain activities including cognitive performance and impaired brain structure (18-21). Moreover, studies suggest that decreasing sedentary activities

improves academic achievements and outcomes of adolescent students (22,23).

There is evidence indicating that physical activity or inactivity affects neuronal function and structure in those areas of the brain that are involved in memory, learning, and performing tasks via changes in blood pressure regulation, oxygen saturation, and angiogenesis (24-28). Furthermore, physical activity or inactivity changes the activity of neurotransmitters such as norepinephrine and serotonin, thereby facilitating information processing (29,30). Moreover, physical activity or inactivity modifies neurotrophins such as insulin-like growth factor-I, brain-derived neurotrophic factor, and basic fibroblast growth factor. These altered neurotrophins sustain neuronal differentiation and survival in the brain (31). However, the specific mechanisms fundamental to this association are still unclear.

Nevertheless, at the epidemiological level, we hypothesized that physical inactivity such as watching TV would be negatively associated with academic record because physical inactivity causes obesity, which in turn leads to decreased brain activity. This study certainly showed that those spending more time engaged in physical inactivity are predisposed to a below-average academic record. We recommend that parents and guardians restrict the time spent engaging in inactive physical activities such as watching TV to less than 1 hour per day at home to prevent decreased academic performance in adolescents.

Our study has several limitations. First, this study was a cross-sectional epidemiological study. For this reason, we could not provide definitive evidence of a cause-and-effect relationship; instead, we assessed the relationship between the duration of physical inactivity and academic record. Second, the questionnaire was self-administered, using online methods; therefore, information such as family's socioeconomic status and parents' education level was obtained from the adolescents, not from the parents. Therefore, these data might be inaccurate. Third, "academic record" data as obtained through the KYRBWS-V did not include actual academic outcomes such as test scores or behavior at school; these factors might contribute

to academic record. Nevertheless, because this KYRBWS-V sampled 75,066 students from all parts of Korea, it was highly representative of the Korean student population; thus, the relationship between physical inactivity and academic record can be generalized to all Korean adolescents.

Conclusion

We conclude that Korean adolescents who spend more time engaged in physical inactivities are predisposed to a below-average academic record, regardless of gender, age, BMI, family's socioeconomic status, parents' education level, and frequency of vigorous or moderate PA and muscular strength exercises.

Ethical considerations

Ethical issues (Including plagiarism, Informed Consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc) have been completely observed by the authors.

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