Association between Frequency of Breakfast Consumption and Academic Performance in Healthy Korean Adolescents

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Abstract

Background: The purpose of this study was to examine whether the frequency of breakfast consumption was related to academic performance in healthy Korean adolescents.

Methods: We analyzed data from the seventh Korea Youth Risk Behavior Web-based Survey conducted in 2011, in which 75,643 adolescents from school grades 7–12 participated. We assessed the association between the frequency of breakfast consumption (per week) and academic performance using multivariate logistic regression analysis after adjusting for covariates such as age, body mass index, frequency of smoking, frequency of drinking, parents' education level, family economic status, frequency of vigorous physical activity(PA), frequency of moderate PA, frequency of muscular strength exercises, and level of mental stress.

Results: For male adolescents, the odds ratios(ORs) for achieving average or higher academic performance according to the breakfast frequency per week were once per week, 1.004(P=0.945); twice per week, 0.915(P=0.153); 3 days per week, 0.928(P=0.237); 4 days per week, 1.087(P=0.176); 5 days per week, 1.258(P<0.001); 6 days per week, 1.473(P<0.001); and every day, 1.700(P<0.001), compared to no breakfast per week. For female adolescents, the ORs for achieving average or higher academic performance according to the breakfast frequency were once per week, 1.068(P=0.320); twice per week, 1.140(P=0.031); 3 days per week, 1.179(P=0.004); 4 days per week, 1.339(P<0.001); 5 days per week, 1.449(P<0.001); 6 days per week, 1.768(P<0.001); and every day, 1.922(P<0.001), compared to no breakfast per week.

Conclusion: The frequency of breakfast consumption is positively correlated with academic performance in both male and female healthy adolescents in Korea.

Keywords: Academic performance, Adolescent, Breakfast, Korea, Youth Risk Behavior, Web-based Survey

Introduction

Adolescent obesity has become a serious public health problem and social issue throughout the world. According to the results of the 2007–2008 National Health and Nutrition Examination Survey conducted by the US Centers for Disease Control and Prevention, approximately 17% (12.5 million) of US children and those aged 2–19 years are obese. Furthermore, this report demonstrated that obesity prevalence among children and adolescents has almost tripled since 1980 (1).

According to results from the fifth Korea National Health and Nutrition Examination Survey of adolescents aged 12–18 years in 2010, 4.9% were overweight and 12.7% were obese. Furthermore, the prevalence of overweight and obesity in Korea is increasing by the year (2).

Obesity is associated with negative health outcomes such as diabetes, cardiovascular diseases (heart disease and stroke), musculoskeletal disorders (especially osteoarthritis), and some cancers (endometrial, breast, and colon) (3). Furthermore,

because several studies have reported that approximately 80% of obese adolescents become obese adults, it is important to prevent and manage obesity during adolescence (4-5). Increased energy intake is a major risk factor for obesity (6-7). Hence, obese people may attempt to decrease their energy intake through a diet program or diet control.

Skipping breakfast is one method for diet control. Although skipping breakfast decreases energy intake in the morning, it is associated with an increased prevalence of overweight and obesity (8-9). Studies have shown that regularly skipping breakfast is closely associated with increased rates of obesity in all age groups (10-13).

Recently, studies have demonstrated that obesity is associated with reduced cognitive and memory functions via alterations in brain structure (14-17). These results indicate that obesity could be linked to academic achievement and performance in adolescents. Therefore, because of its strong connection to the prevalence of obesity, skipping breakfast might be also associated with academic achievement and performance. However, there is little epidemiologic evidence for an association between frequency of breakfast consumption and academic performance in adolescents. Therefore, this study examined whether the frequency of breakfast consumption (per week) was related to academic performance in healthy Korean adolescents.

Methods

The seventh Korea Youth Risk Behavior Web-based Survey (KYRBWS-VII) was conducted using a complex sample design involving stratification, clustering, and multistage sampling methods to obtain data from a retrospective ***cohort***. The KYRBWS-VII was a nationally representative school-based survey conducted by the Korea Centers for Disease Control and Prevention (KCDCP) to evaluate the prevalence of health risk behavior among adolescent students in Korea. The KCDCP has reported the details of the data collection procedures separately (18). The KYRBWS has been determined to be valid and reliable (19-20).

The present study drew on KYRBWS-VII data for students from 400 middle schools and 400 high schools to evaluate the association between frequency of breakfast consumption and academic performance, taking into account potential covariates such as age, body mass index, frequency of smoking, frequency of drinking, parents' education level, family economic status, frequency of vigorous physical activity (PA), frequency of moderate PA, frequency of muscular strength exercises, and level of mental stress.

The adolescent students who participated in this survey were assigned unique identification (ID) numbers by their classroom teachers. The students accessed the survey webpage using their ID numbers and answered a question about their willingness to participate. Willing participants self-administered the questionnaire anonymously at school, and those unwilling did not progress further. As the survey did not collect private information that could be used to identify the participants (such as name, school, home address, telephone number, social security number, or presence of any disease), ethical approval was not required.

The response rate was 95.5% (75,643 of 79,202 students). The characteristics of the subjects are listed in Table 1.

Independent variables

Self-reported academic performance was determined by asking the respondent to rate their average academic performance in the previous 12 months. There were 5 possible responses: [1] very high, [2] high, [3] average, [4] low, and [5] very low. Based on the responses to this question, participants were divided into 2 groups for multivariate logistic regression: [1] those with below-average academic performance and [2] those with average or higher academic performance.

Dependent variables

Breakfast frequency was determined by asking respondents the number of days per week on which they had consumed breakfast. The possible responses were: [1] no breakfast, [2] 1 day, [3] 2 days, [4] 3 days, [5] 4 days, [6] 5 days, [7] 6 days, and [8] every day.

Table 1: The characteristics of subjects

Variables		Male adolescents (n = 37,873)	Female adolescents (n = 37,770)	Total (n = 75,643)
Age (years)		15.08 ± 1.75	15.12 ± 1.75	15.10 ± 1.75
Height (cm)		169.90 ± 8.02	159.99 ± 5.36	164.95 ± 8.43
Weight (kg)		60.51 ± 11.67	51.84 ± 7.81	56.18 ± 10.84
Body mass index (kg/m²)		20.86 ± 3.21	20.22 ± 2.63	20.54 ± 2.95
School performance Number (%)	Very high	4,606 (12.2)	3,707 (9.8)	8,313 (11.0)
	High	8,986 (23.7)	9,267 (24.6)	18,253 (24.1)
	Average	10,055 (26.6)	10,320 (27.3)	20,375 (26.9)
	Low	9,362 (24.7)	9,973 (26.4)	19,335 (25.6)
	Very low	4,864 (12.8)	4,503 (11.9)	9,367 (12.4)
Frequency of breakfast consumption per week Number (%)	No breakfast per week	5,162 (13.6)	4,187 (11.1)	9,349 (12.4)
	1 day	1,974 (5.1)	2,174 (5.8)	4,121 (5.4)
	2 days	2,383 (6.3)	2,626 (7.0)	5,009 (6.6)
	3 days	2,579 (6.8)	2,874 (7.6)	5,453 (7.2)
	4 days	2,119 (5.6)	2,435 (6.4)	4,554 (6.0)
	5 days	3,286 (8.7)	3,789 (10.0)	7,075 (9.4)
	6 days	3,606 (9.5)	4,386 (11.6)	7,992 (10.6)
	Every day	16,791 (44.3)	15,299 (40.5)	32,090 (42.4)
Frequency of smoking Number (%)	No smoking	31,522 (83.2)	35,133 (93.0)	66,655 (88.1)
	1-2 day(s) per month	1,076 (2.8)	576 (1.5)	1,652 (2.2)
	3-5 days per month	477 (1.3)	260 (0.7)	737 (1.0)
	6-9 days per month	405 (1.1)	177 (0.5)	582 (0.8)
	10-19 days per month	493 (1.3)	244 (0.6)	737 (1.0)
	20-29 days per month	563 (1.5)	250 (0.7)	813 (1.1)
	Every day	3,337 (8.8)	1,130 (3.0)	4,467 (5.9)
Frequency of drinking Number (%)	No drinking	29,021 (76.6)	31,028 (82.1)	60,049 (79.4)
	1-2 day(s) per month	4,607 (12.2)	4,117 (10.9)	8,724 (11.5)
	3-5 days per month	1,734 (4.6)	1,116 (3.0)	2,850 (3.8)
	6-9 days per month	1,120 (3.0)	668 (1.8)	1,788 (2.4)
	10-19 days per month	804 (2.1)	532 (1.4)	1,336 (1.8)
	20-29 days per month	362 (1.0)	223 (0.6)	585 (0.8)
	Every day	225 (0.6)	86 (0.2)	311 (0.4)
Father's education level Number (%)	Middle school or lower	1,843 (4.9)	1,943 (5.1)	3,786 (5.0)
	High school	12,587 (33.2)	13,954 (36.9)	26,541 (35.1)
	College or higher	16,601 (43.8)	15,908 (42.1)	32,509 (43.0)
	Unknown	6,842 (18.1)	5,965 (15.8)	12,807 (16.9)
Mother's education level Number (%)	Middle school or lower	1,765 (4.7)	2,025 (5.4)	3,790 (5.0)
	High school	16,192 (42.8)	18,402 (48.7)	34,594 (45.7)
	College or higher	12,723 (33.6)	12,022 (31.8)	24,745 (32.7)
	Unknown	7,193 (19.0)	5,321 (14.1)	12,514 (16.5)

Data are expressed as mean ± standard deviation or number (%)

Table 1: Cond...

Variables		Male adolescents (n = 37,873)	Female adolescents (n = 37,770)	Total (n = 75,643)
Family economic status Number (%)	Very rich	3,165 (8.4)	1,612 (4.3)	4,777 (6.3)
	Rich	9,401 (24.8)	8,253 (21.9)	17,654 (23.3)
	Average	16,929 (44.7)	18,833 (49.9)	35,762 (47.3)
	Poor	6,336 (16.7)	7,213 (19.1)	13,549 (17.9)
	Very poor	2,042 (5.4)	1,859 (4.9)	3,901 (5.2)
Frequency of vigorous PA Number (%)	No vigorous PA	6,095 (16.1)	15,942 (42.2)	22,037 (11.0)
	Once a week	6,414 (16.9)	7,995 (21.2)	14,409 (19.0)
	Twice a week	7,481 (19.8)	6,139 (16.3)	13,620 (18.0)
	Thrice a week	7,111 (18.8)	4,097 (10.8)	11,208 (14.8)
	4 times a week	3,176 (8.4)	1,382 (3.7)	4,558 (6.0)
	5 times a week or more	7,596 (20.1)	2,215 (5.9)	9,811 (13.0)
Frequency of moderate PA Number (%)	No moderate PA	7,383 (19.5)	13,794 (36.5)	21,177 (28.0)
	Once a week	7,276 (19.2)	8,776 (23.2)	16,052 (21.2)
	Twice a week	7,752 (20.5)	6,851 (18.1)	14,603 (19.3)
	Thrice a week	6,523 (17.2)	4,500 (11.9)	11,023 (14.6)
	4 times a week	2,565 (6.8)	1,484 (3.9)	4,049 (5.4)
	5 times a week or more	6,374 (16.8)	2,365 (6.3)	8,739 (11.6)
Frequency of muscular strength exercises Number (%)	No muscular strength exercises	13,608 (35.9)	25,283 (66.9)	38,891 (51.4)
	Once a week	7,483 (19.8)	6,014 (15.9)	13,497 (17.8)
	Twice a week	5,481 (14.5)	2,909 (7.7)	8,390 (11.1)
	Thrice a week	4,542 (12.0)	1,649 (4.4)	6,191 (8.2)
	4 times a week	1,781 (4.7)	628 (1.7)	2,409 (3.2)
	5 times a week or more	4,978 (13.1)	1,287 (3.4)	6,265 (8.3)
Level of mental stress Number (%)	Very high	3,619 (9.6)	5,472 (14.5)	9,091 (12.0)
	High	9,928 (26.2)	13,098 (34.7)	23,026 (30.4)
	Average	16,649 (44.0)	14,833 (39.3)	31,482 (41.6)
	Low	6,468 (17.1)	3,968 (10.5)	10,436 (13.8)
	Very low	1,209 (3.2)	399 (1.1)	1,608 (2.1)

Data are expressed as mean ± standard deviation or number (%)
PA; physical activity

Covariates
[1] Age: The adolescents' ages, defined by the KYRBWS-VII data, were used without adaptation.
[2] Body mass index: Respondents were asked to self-record their height and weight, and the body mass index (kg/m^2) was calculated.

[3] Frequency of smoking: Possible responses ranged from 1 (I do not smoke) to 7 (every day).
[4] Frequency of drinking: Possible responses ranged from 1 (I do not drink) to 7 (every day).
[5] Parents' education level: Possible responses ranged from 1 (middle school or lower) to 3 (college or higher).

[6] Family economic status: Possible responses ranged from 1 (very rich) to 5 (very poor).
[7] Frequency of vigorous PA such as digging, aerobics, heavy lifting, or fast cycling: Possible responses ranged from 1 (none) to 6 (more than 5 days per week).
[8] Frequency of moderate PA such as cycling at a regular pace, carrying light loads, or playing doubles tennis: Possible responses ranged from 1 (none) to 6 (more than 5 days per week).
[9] Frequency of muscular strength exercises such as sit-ups, push-ups, and weight lifting or weight training: Possible responses ranged from 1 (none) to 6 (more than 5 days per week).
[10] Mental stress: Possible responses ranged from 1 (very high) to 5 (none).

Statistical analysis

All results are presented as mean ± standard deviation. Multivariate logistic regression analyses were conducted to determine whether frequency of breakfast consumption was related to academic performance after adjusting for covariates. Statistical significance was set at $P < 0.05$, and all analyses were performed using SPSS ver. 20.0 (SPSS, Chicago, IL, USA).

Results

The results of the multivariate logistic regression analyses for academic performance in relation to breakfast frequency are shown in Table 2. A total of 5,162 (13.6%) male adolescents and 4,187 (11.1%) female adolescents skipped breakfast every day.

Table 2: The results of the multivariate logistic regression analyses for academic performance in relation to breakfast frequency per week in healthy Korean adolescents

Frequency of breakfast consumption per week		Below-average academic performance Vs. Average academic performance or higher					
		Case	ß	S.E.	OR	95% CI	*P*-value
Male adolescents	No breakfast per week	5,162	Ref				
	1 day	1,974	0.004	0.061	1.004	0.891-1.132	0.945
	2 days	2,383	-0.088	0.062	0.915	0.811-1.034	0.153
	3 days	2,579	-0.074	0.063	0.928	0.821-1.050	0.237
	4 days	2,119	0.083	0.061	1.087	0.963-1.226	0.176
	5 days	3,286	0.229	0.060	1.258	1.117-1.416	<001***
	6 days	3,606	0.388	0.055	1.473	1.321-1.643	<001***
	Every day	16,791	0.531	0.039	1.700	1.575-1.835	<001***
Female adolescents	No breakfast per week	4,187	Ref				
	1 day	2,174	0.065	0.066	1.068	0.938-1.214	0.320
	2 days	2,626	0.131	0.060	1.140	1.012-1.284	0.031*
	3 days	2,874	0.165	0.057	1.179	1.055-1.318	0.004**
	4 days	2,435	0.292	0.061	1.339	1.187-1.510	<001***
	5 days	3,789	0.371	0.059	1.449	1.290-1.628	<001***
	6 days	4,386	0.570	0.059	1.768	1.575-1.985	<001***
	Every day	15,299	0.653	0.044	1.922	1.762-2.097	<001***

S.E; Standard Error, OR; Odd Ratio, CI; Confidence Interval
*$P<0.05$, **$P<0.01$, ***$P<0.001$; tested by multivariable logistic regression analysis after adjusting for covariates such as age, body mass index, frequency of smoking, frequency of drinking, parents' education level, family economic status, frequency of vigorous PA, frequency of moderate PA, frequency of muscular strength exercises, and level of

mental stress

For male adolescents, the odds ratios (ORs; 95% confidence interval [CI]) for achieving average or higher academic performance according to the frequency of breakfast consumption (per week) were once per week, 1.004 (0.891–1.132; C = 0.945); twice per week, 0.915 (0.811–1.034; P = 0.153); 3 times per week, 0.928 (0.821–1.050; P = 0.237); 4 times per week, 1.087 (0.963–1.226; P = 0.176); 5 times per week, 1.258 (1.117–1.416; P < 0.001); 6 times per week, 1.473 (1.321–1.643; P < 0.001); and every day, 1.700 (1.575–1.835; P < 0.001), compared to no breakfast per week. For female adolescents, the ORs (95% CI) for achieving average or higher academic performance according to frequency of breakfast consumption (per week) were once per week, 1.068 (0.938–1.214; P = 0.320); twice per week, 1.140 (1.012–1.284; P = 0.031); 3 times per week, 1.179 (1.055–1.318; P = 0.004); 4 times per week, 1.339 (1.187–1.510; P < 0.001); 5 times per week, 1.449 (1.290–1.628; P < 0.001); 6 times per week, 1.768 (1.575–1.985; P < 0.001); and every day, 1.922 (1.762–2.097; P < 0.001), compared to no breakfast per week.

Discussion

Skipping breakfast is associated with obesity, increased appetite throughout the remainder of the day, and overeating in the evening (21-22). Since obesity is also associated with reduced cognitive and memory functions via alterations in the brain structure, a positive association between frequency of breakfast consumption and academic performance can be expected. This study indicated that even after controlling for covariates, frequency of breakfast consumption was positively related to academic performance in both male and female healthy adolescents in Korea.

Recently, several studies have reported that breakfast consumption is associated with some aspects of brain function, such as neural network activity and cognitive performance (23-24). As breakfast is important for brain development in adolescents, a high-quality breakfast is strongly recommended

(25). Furthermore, Grantham-McGregor's (2005) review paper highlighted the fact that many studies have demonstrated an association between breakfast consumption and engagement at school, including such factors as enrolment, attendance, achievement, classroom behavior, and the decision to drop out of school (26).

Adolescence is a phase of psychological change, characterized by the achievement of sexual maturity, rapid physical growth, and increased hormone levels (27). In this study, a strong relationship was found between breakfast consumption and academic performance. This implies that during the adolescent years, breakfast consumption is critical for brain function, and by extension, academic performance. As the results from this epidemiological study indicate, eating breakfast regularly may positively affect academic performance in both male and female healthy adolescents in Korea.

Interestingly, breakfast consumption was significantly associated with academic performance in female adolescents when consumed at least twice per week; however, it was significantly associated with academic performance in male adolescents only when consumed at least 5 days per week. Adolescence affects males and females differently, and it could be that female adolescents are more likely to experience the effects of breakfast consumption on academic performance. Subsequent well-designed studies should be performed to determine the differential effects of frequency of breakfast consumption on academic performance in male and female adolescents.

The study has several limitations. First, it did not include information on the quantity of food consumed at breakfast, the quality of the breakfast (including such factors as overeating and appetite), and the type of food consumed. Second, the information regarding the economic status of each family was obtained from the respondents, not the parents, and their perceptions may have been inaccurate. Third, since this study was retrospective and cross-sectional, we could not determine cause and effect, only interrelationships. However, the

strength of our study lies in its inclusion of data from 75,643 adolescents from a nationally representative sample in Korea; we believe that the results represent the true relationship between frequency of breakfast consumption and academic performance in healthy Korean adolescents.

Conclusion

Increasing breakfast frequency was positively correlated with academic performance in both male and female healthy adolescents in Korea, regardless of age, body mass index, frequency of smoking, frequency of drinking, parents' education level, family economic status, frequency of vigorous PA, frequency of moderate PA, frequency of muscular strength exercises, and level of mental stress.

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.

Acknowledgements

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