

Associations between dietary patterns and screen time among Korean adolescents

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Abstract

Data are limited on the association between dietary patterns and screen time among Korean adolescents. The present study identified dietary patterns of 691 adolescents, aged 13-18 years, who had participated in the Third Korean National Health and Nutrition Examination Survey (KNHANES III) and analyzed their associations with screen time. Screen time was defined as the time spent watching TV, using a computer, or playing video games was calculated as a sum of all these times. Dietary patterns and their factor scores were derived from a food frequency questionnaire using the factor analysis method. To analyze the association between dietary patterns and screen time, we conducted multiple linear regression analysis. We also performed multiple logistic regression analysis to estimate odds ratios (OR) of excessive screen time (2 hours or longer per day) and 95% confidence intervals (CI). We identified 2 dietary patterns labeled “the Korean healthy dietary pattern” and “the Western diet and fast foods pattern”. The former included mixed grains, legumes, potatoes, red meat, eggs, fish, dairy products, fruits, vegetables, seaweeds, and mushrooms, whereas the latter included noodles, bread, red meat, poultry, fast foods, snack, and soft drinks. After controlling for potential confounding factors, factor scores for the Korean healthy dietary pattern were inversely associated (P -value for trend < 0.01) and those for the Western diet and fast foods pattern were positively associated with the screen time (P -value for trend < 0.01). Adolescents in the top tertile of the scores for the Korean healthy dietary pattern had a multivariable-adjusted OR [95% CI] of 0.44 (0.25-0.75) for excessive screen time compared with those in the lowest tertile. On the basis of these findings, adolescents who have excessive screen time may need to be encouraged to consume a more healthy diet.

Key Words: Adolescents, dietary patterns, screen time, the Korean national health and nutrition examination survey

Introduction

Rapid economic growth of Korea has changed people’s lifestyle; in particular, the diet has become westernized [1] and sedentary time has increased [2]. Currently, a common sedentary behavior among children and adolescents is partaking in screen time, which includes time spent watching TV, using a computer, or playing DVD/video games. The American Academy of Pediatrics recommends that children and adolescents should limit the time for watching TV to 2 hours per day [3], but only 27% of them meet this recommendation [4]. Screen time is reportedly associated with dietary habits. In children and adolescents, longer screen time is positively associated with a higher intake of energy-dense foods such as high-fat foods, sugary snacks, or soft drinks [5-7] and inversely associated with the consumption of healthy foods such as vegetables and fruits [6]. Previous studies have reported data on the association between screen time and dietary patterns. A study including a French population showed that time spent watching TV is inversely associated with an unhealthy dietary pattern, which reflects a high consumption of alcohol and meat or convenience foods [8]. Another study among

Spanish children and adolescents showed that more than 2 hours of TV-watching is likely to be associated with the dietary pattern of a high consumption of sweets, salted snacks, bakery products, and soft drinks [9]. On the contrary, a healthy dietary pattern such as the Mediterranean dietary pattern was found to be inversely associated with screen time among European children [10]. However, there is limited information on the association between dietary patterns and screen time in Asian populations.

It was reported that the penetration rate of internet access in the South Korea population has reached almost 100%, which is the highest level worldwide [11]. Thus, we propose our hypothesis on the association between diet and screen time: more Korean adolescents are exposed to high screen time compared with those in other countries and they have thus developed unhealthy dietary patterns. To our knowledge, no study has been conducted on the association between dietary patterns and screen time among Korean adolescents; thus, the present study was aimed to derive dietary patterns and analyze such association using data from the Korean National Health and Nutrition Examination Survey (KNHANES).

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Subjects and Methods

Study population

The KNHANES is a cross-sectional investigation, which includes health examinations and surveys on socio-demographic characteristics, nutritional status, health behaviors, and disease among a representative Korean population. In this study, we utilized the KNHANES data collected in 2005 (<http://knhanes.cdc.go.kr>). Data on variables regarding screen time were available, and we identified 872 adolescents, aged 13-18 years, who provided complete information on diet and screen time. Only data for 691 adolescents were analyzed because of incomplete information on anthropometric measures, physical activity, and inappropriate calorie intake (less than 120 kJ/day or more than 1,200 kJ/day).

Dietary information

We utilized dietary information collected using a food frequency questionnaire (FFQ), which is generally used in large scale epidemiologic studies [12,13]. The FFQ included a total of 63 food items with 10 intake frequency categories ranging from “almost never” to “3 or more times per day”. We calculated the average frequency of consumption for a specific food item and then added up the frequencies of all the food items belonging to the 23 food groups. These groups were classified on the basis of an earlier study on dietary patterns [14]. However, a food group for oil and seasonings was omitted due to the unavailability of such information in the FFQ and fast foods such as hamburgers, pizza, and fried foods were grouped in the present study.

Definition of screen time

Screen time was defined as time spent watching TV, using a computer, or playing video games. The information for screen time was obtained from the 4 following questions: (1) During the last week (Monday to Friday), what was the daily average time spent watching TV?; (2) During the last weekend, what was the daily average time spent watching TV?; (3) During the last week (Monday to Friday), what was the daily average time spent using a computer (in particular, the internet) or playing video games?; (4) During the last weekend, what was the daily average time spent using a computer (in particular, the internet) or playing video games? We added up each participant's average screen times per day and then classified them into 2 groups using 2 hours as the cutoff point [3,5,7,9].

Potential confounding factors

We considered age, sex, height, weight, physical activity, and total calorie intake as potential confounding factors. The KNHANES health examination measures height and body weight

down to 0.1 cm and 0.1 kg, respectively, for each participant dressed in light clothing without shoes. We collected questionnaire information on the number of days of regular exercise that the participants performed during the last week and then categorized them into 3 groups: “low activity” for those who almost never exercised, “moderate activity” for those who exercised 1-4 days a week, and “high activity” for those who exercised 5-7 days a week. We also collected data on the total calorie intake from a 24-hour dietary recall.

Statistical analysis

We used the factor analysis method to determine dietary patterns from the dietary information collected from the 23 food groups. To decide the number of prevailing dietary patterns, we evaluated eigenvalues (greater than 1.3) according to a scree plot. To increase interpretability, we used the varimax rotation function, which creates a simple factor-loading matrix by orthogonal transformation. Once the major factors were determined, factor scores for each factor were calculated and assigned to each individual. To analyze the association between the factor scores and screen time, we conducted multiple linear regression analysis after accounting for age, sex, height, weight, physical activity, and total calorie intake. Furthermore, we conducted multiple logistic regression analysis to calculate odds ratios (OR) and 95% confidence intervals (CI) for the association between the tertiles of the factor scores and the binary variable of screen time (≤ 2 hours/day or > 2 hours/day). To characterize participants in the 2 groups (≤ 2 hours/day or > 2 hours/day), we used descriptive statistics, the student's *t*-test, and the chi-square test. In this study, the SAS program (SAS 9.1.3, 2008, SAS Institute, Cary, NC, USA) was used for all statistical analyses.

Results

Characteristics and dietary patterns

Table 1 shows the descriptive characteristics of 691 adolescents. The 2 groups (screen time ≤ 2 hours/day versus > 2 hours/day) showed insignificant differences in age, sex, and physical activity. Subjects with screen time ≤ 2 hours/day were more likely to consume rice (*P*-value < 0.01), mixed grains (*P*-value < 0.01), legumes (*P*-value < 0.01), and eggs (*P*-value < 0.05) whereas those with screen time > 2 hours/day were more likely to consume noodles (*P*-value = 0.01).

Table 2 shows dietary patterns derived using the factor analysis method by using the information from the major food groups. Two types of dietary patterns were identified after the rotation and were labeled as “Korean healthy dietary pattern” and “Western diet and fast foods pattern” on the basis of major food groups characterizing each pattern. The Korean healthy dietary pattern was contributed to by a high consumption of mixed

Table 1. Descriptive characteristics of 691 adolescents from the 2005 Korea National Health and Nutrition Examination Survey

Variables	Screen time		P-value ¹⁾
	≤ 2 hrs/day	> 2 hrs/day	
Number of participants	583	108	
Age, yrs	15.10 ± 1.65 ²⁾	15.13 ± 1.64	0.68
Age groups, %			
13-15 yrs	59	62	0.73
16-18 yrs	41	38	
Sex, %			
Boys	52	57	0.51
Girls	48	43	
Physical activity level, %			
Low	31	33	0.86
Moderate	58	54	
High	11	13	
Daily intake frequencies of food groups			
Rice	2.64 ± 0.58	2.46 ± 0.65	< 0.01
Mixed grains	1.32 ± 1.10	1.00 ± 0.99	< 0.01
Noodles	0.38 ± 0.37	0.57 ± 0.73	0.01
Bread	0.35 ± 0.39	0.35 ± 0.53	0.89
Rice cake	0.16 ± 0.29	0.16 ± 0.20	0.79
Legumes	1.08 ± 1.06	0.81 ± 0.81	< 0.01
Potatoes	0.38 ± 0.42	0.35 ± 0.43	0.47
Red meat	0.87 ± 0.91	0.86 ± 0.97	0.89
Poultry	0.23 ± 0.29	0.22 ± 0.28	0.74
Eggs	0.53 ± 0.49	0.44 ± 0.38	< 0.05
Fish	1.33 ± 1.17	1.31 ± 1.13	0.92
Dairy products	1.95 ± 1.26	1.81 ± 1.12	0.28
Fruits	2.11 ± 1.88	1.84 ± 1.74	0.17
Vegetables	4.83 ± 2.75	4.56 ± 2.49	0.33
Seaweeds	0.78 ± 0.68	0.73 ± 0.63	0.45
Fast foods	0.31 ± 0.38	0.31 ± 0.32	0.99
Snack	0.63 ± 0.54	0.72 ± 0.76	0.25
Salty fish	0.09 ± 0.29	0.07 ± 0.16	0.29
Mushrooms	0.22 ± 0.31	0.18 ± 0.22	0.17
Soft drink	0.38 ± 0.48	0.42 ± 0.48	0.36
Coffee	0.14 ± 0.34	0.11 ± 0.25	0.31
Tea	0.23 ± 0.54	0.23 ± 0.59	0.99
Alcohol	0.03 ± 0.12	0.04 ± 0.12	0.29

¹⁾ Proportion or mean of each variable was tested by using the chi-square test or student's t-test.

²⁾ Mean ± SD.

grains, legumes, potatoes, red meat, eggs, fish, dairy products, fruits, vegetables, seaweeds, and mushroom. The Western diet and fast foods pattern was contributed to by a high consumption of noodles, bread, red meat, poultry, fast foods, snack, and soft drinks.

Association between dietary patterns and screen time

Table 3 presents linear regression estimates for the association between the dietary patterns and screen time. Factor scores for the Korean healthy dietary pattern were inversely associated with screen time after adjusting for age, sex, height, weight, physical

Table 2. Rotated factor loading matrix for dietary patterns¹⁾

Food groups	Rotated factor loading matrix	
	Korean healthy dietary pattern	Western diet and fast foods pattern
Rice	0.37	-0.39
Mixed grains	0.49	-0.40
Noodles	0.06	0.54
Bread	0.12	0.48
Rice cake	0.19	0.36
Legumes	0.55	-0.04
Potatoes	0.53	0.30
Red meat	0.47	0.49
Poultry	0.36	0.49
Eggs	0.49	0.26
Fish	0.66	0.31
Dairy products	0.41	0.29
Fruits	0.45	0.24
Vegetables	0.68	0.04
Seaweeds	0.54	0.13
Fast foods	0.26	0.53
Snack	0.24	0.53
Salty fish	0.19	-0.01
Mushrooms	0.50	0.10
Soft drink	0.09	0.60
Coffee	0.04	0.24
Tea	0.20	0.10
Alcohol	-0.13	0.26

¹⁾ Foods or food groups with absolute values of 0.40 or greater are considered major contributors.

Table 3. Linear regression estimates and statistical significance for the association between the dietary patterns and screen time

Dietary patterns	Models ¹⁾	β ²⁾	SE	t-value	P-value
Korean healthy dietary pattern	Model 1	-0.087	0.027	-3.17	< 0.01
	Model 2	-0.088	0.028	-3.17	< 0.01
	Model 3	-0.093	0.028	-3.34	< 0.001
Western diet and fast foods pattern	Model 1	0.103	0.027	3.75	< 0.01
	Model 2	0.109	0.028	3.95	< 0.001
	Model 3	0.113	0.028	4.09	< 0.001

¹⁾ Model 1: an unadjusted model, Model 2: a multiple linear regression model adjusted for age and sex, Model 3: a multiple linear regression model adjusted for age, sex, height, weight, physical activity, and total calorie intake.

²⁾ Regression coefficient estimates.

activity, and total calorie intake (P -value < 0.001). Factor scores for the Western diet and fast foods pattern were positively associated with screen time after adjusting for the abovementioned covariates (P -value < 0.001).

Fig. 1 shows the association between the tertiles of dietary pattern scores and excessive screen time (more than 2 hours per day) after adjusting for potential confounding factors. The second and third tertiles of factor scores for the Korean healthy dietary pattern showed ORs of 0.64 (95% CI: 0.39-1.05) and 0.44 (95% CI: 0.25-0.75), respectively, compared with the top tertile (P -value for trend < 0.01). In contrast, the second and third tertiles of factor scores for the Western diet and fast foods pattern

Table 4. Linear regression estimates and statistical significance for the association between screen time and dietary patterns by sex and age groups

Variables	Groups	Dietary patterns	β ¹⁾	SE	t-value	P-value
Sex	Boys (n=364)	Korean healthy dietary pattern	-0.110	0.038	-2.88	<0.01
	Girls (n=327)		-0.044	0.041	-1.1	0.27
Age	13-15 yrs (n=412)		-0.106	0.035	-3.02	<0.01
	16-18 yrs (n=279)		-0.064	0.045	-1.43	0.16
Sex	Boys (n=364)	Western diet and fast foods pattern	0.059	0.038	1.58	0.12
	Girls (n=327)		0.135	0.041	3.28	0.001
Age	13-15 yrs (n=412)		0.082	0.035	2.37	<0.05
	16-18 yrs (n=279)		0.148	0.045	3.32	0.001

¹⁾Regression estimates adjusted for age, sex, height, weight, energy intake, and physical activity.

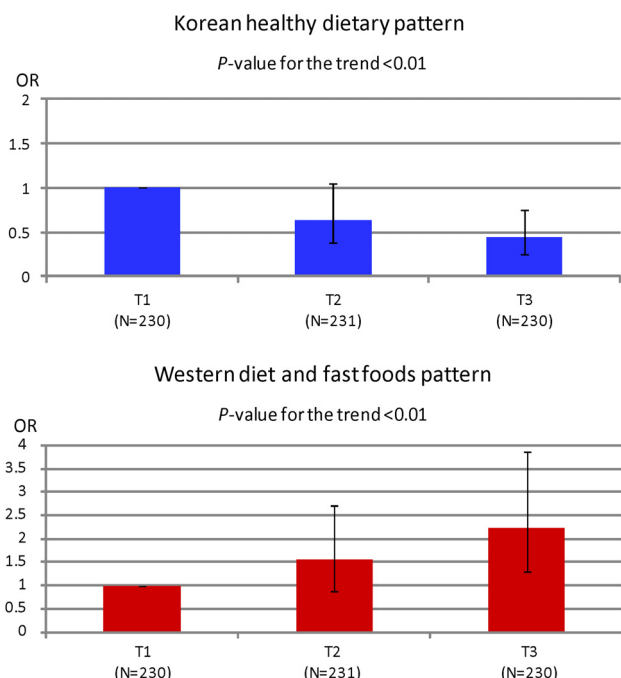


Fig 1. Odds ratios (OR) and 95% confidence intervals (CIs) for the association between the tertiles of dietary pattern scores and screen time longer than 2 hours. Odds ratios of spending screen time > 2 hrs/day in the association with the tertiles of the dietary pattern scores compared with the first tertile (T1).

showed ORs of 1.55 (95% CI: 0.89- 2.70) and 2.24 (1.31- 3.86), respectively, compared with the top tertile (*P*-value for trend < 0.01).

Data for the association between the dietary patterns and screen time by sex and age groups are demonstrated in Table 4. A stronger inverse association between the Korean healthy dietary pattern and screen time was observed for boys or adolescents aged 13-15 years (middle-school students) (*P* < 0.01), but not for girls or high-school students aged 16-18 years. A stronger positive association between the Western diet and fast foods pattern and screen time was observed for girls or adolescents aged 16-18 years (high-school students) (*P* = 0.001), but not for boys or middle-school students aged 13-15 years.

Discussion

Using the 2005 KNHANES data, we identified 2 major dietary patterns Korean healthy dietary pattern and the Western diet and fast foods pattern among Korean adolescents aged 13-18 years. Furthermore, we observed that the Korean healthy dietary pattern was inversely associated and the Western diet and fast foods pattern was positively associated with screen time.

The Western diet and fast foods pattern determined in this study is similar to those reported in previous studies [1,15]. Kim *et al.* [1] identified 3 types of dietary patterns among Korean adolescents aged 10-19 years: the Korean traditional pattern characterized by a high consumption of rice, kimchi, legumes, fish, and seaweed; the Western pattern characterized by a high consumption of flour, bread, hamburgers, pizza, cereals, snacks, sweets, sugar, meats, and beverages, and the modified pattern characterized by a high consumption of noodles, dumplings, rice, and kimchi. Song Y *et al.* [15] also identified 3 types of dietary patterns: the traditional pattern, which is contributed to by rice, kimchi, fish and vegetables, the Western pattern, which is contributed to by flour, bread, hamburgers, pizza, meat, meat products, dairy products and soft drinks, and the traditional dietary pattern, which is contributed to by noodles and dumplings. Some data are also available on the dietary patterns in adolescents with different ethnicities. The Western style diet and the healthy dietary pattern were identified among Australian adolescents, and the healthy dietary pattern was characterized by a high consumption of whole grains, fruit, vegetables, fish and legumes [16]. Among Brazilian adolescents, the Western style dietary pattern, the traditional dietary pattern, and the mixed dietary pattern were prevalent, and their traditional dietary pattern was shown to be high in the consumption of rice, bread, milk, and beans [17]. Among Spanish adolescents, the Western style dietary pattern and the Mediterranean dietary pattern were identified, and the Mediterranean diet was characterized by the high consumption of dairy products, fish and seafood, eggs, legumes, fruit and vegetables, and olive oil [10]. In comparison to these patterns, the Western style dietary pattern was similar to that observed among Korean adolescents although their traditional diet or healthy dietary patterns were unique. In Korea, a typical Western style diet has become one of the most common dietary patterns

among adolescents as well as among adults, and Western foods are more widely available now than they were 30 years ago. Because it is known that the Western style diet is related to an increased risk of coronary heart disease, type 2 diabetes mellitus, colon cancer, obesity, hypertension, and autoimmune disease [18,19,20], Koreans are more likely to be at risk of these chronic diseases. Among adolescents in particular, the Western dietary pattern is reportedly associated with attention-deficit hyperactivity disorder [21] and metabolic syndrome [22]. Since diets in childhood and adolescence affect health as well as eating habits in adulthood, the establishment of a healthy dietary pattern in the early stage of life is critical for the prevention of chronic diseases.

Several studies have examined the association between dietary patterns and screen time. Among French adults, an unhealthy dietary pattern, which reflects a high consumption of alcohol and meat or convenience foods, was inversely associated with time spent watching TV [8]. Among Spanish children and adolescents who spend more than 2 hours a day watching TV, a high consumption of salted snacks, sweets, bakery products, and soft drinks was observed [9]. On the contrary, a healthy dietary pattern such as the Mediterranean dietary pattern was found to be inversely associated with screen time [10]. However, data on the association between dietary patterns and screen time have not been reported for Koreans or other Asian populations. In present study, we observed a significant association between the Western diet and fast foods pattern and screen time. In particular, handheld foods, such as convenience foods, fast foods, and bakery products or snacks, appeared to contribute to the Western diet and fast foods pattern that we identified. On the basis of these findings, we postulate that Korean adolescents with excessive screen time consume increased amounts of handheld foods, with which a person is able to continuously watch TV or view computer screen. A typical Korean meal includes more than 3 dishes (rice, soup, and side dishes) and all dishes are served on a table at the same time; thus, a person should have a formal table setting for a typical Korean meal. This may support our finding that adolescents with excessive screen time were less likely to have the Korean healthy dietary pattern.

The strengths of our study include the use of national data and the analysis of dietary patterns; importantly, this is the first report on the association between diet and screen time among Korean adolescents. In particular, the analysis of dietary patterns provides information of overall dietary habits in real life, whereas that of nutrients or specific food items does not provide any such information. The present study had a few limitations too. First, because of a cross-sectional design, a causal relation between dietary patterns and screen time was undetermined. Thus, a prospective study is warranted to clarify this relation. Second, we were unable to estimate actual amounts of food items consumed because we used the dietary information from the FFQ, which includes only the consumption frequencies of food items. We performed a factor analysis using 24-hour dietary recall data,

but we were unable to identify notable dietary patterns using only 1 day's diet information.

On the basis of our findings, we conclude that excessive screen time may affect not only dietary habits but also nutritional status, growth, and health in Korean adolescents. We suggest that a guideline specifying an acceptable screen time for Korean adolescents is needed, and nutritional education for those spending excessive screen time should be emphasized in schools.

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