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Original Article

The Nonlinear Association Between Internet Using Time for Non-Educational Purposes and Adolescent Health

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Objectives: This study was performed to consider the association between Internet using time for non-educational purposes and adolescent health, and to examine how health status differs between Internet users and non-users.
Methods: We analyzed 2009 data from the Korea Adolescent Risk Behavior Web-Based Survey, conducted on a nationally representative sample of students in grades 7 to 12. A total of 75 066 adolescents were categorized into four groups according to their Internet using time excluding using for educational purposes: non-Internet users (NIUs), occasional Internet users (OIUs) (<1 h/d), moderate Internet users (MIUs) (≥1 and <2 h/d), and heavy Internet users (HIUs) (≥2 h/d). Health factors included eight health risk behavior indices, four mental health indices and six physical health indices.
Results: The distribution of Internet use was as follows: NIUs 17.4%, OIUs 68.1%, MIUs 12.7%, and HIUs 1.7%. In multivariate analysis, using OIUs as a reference, U- or J-shaped associations were observed for five health risk behavior indices (current smoking, current drinking, drug abuse, sexual intercourse, sedentary behavior on weekdays) and four mental health indices (stressed, depressed, suicidal ideation, attempted suicide) in both genders. After removing confounding effects, including age, region, school type, subjective school record, subjective economic status, presence of parents, living with family, and sedentary behavior, these associations were still observed.
Conclusions: Health professionals should consider both Internet non-users (for non-educational purposes) and heavy users to be high-risk groups in terms of health status. Also, more well-designed studies are needed to clarify what factors are working in these nonlinear associations.

Key words: Adolescent, Health, Internet, Time
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INTRODUCTION

Since 1994, the year in which Internet service became common, the Internet has become an important domain of our daily lives [1]. As of 2010, 77.9% of Koreans older than three years old were using the Internet, including 99.9% of teenagers [2]. Adolescents, in particular, are the information-oriented generation, and meeting peer groups in the virtual world, obtaining information, and playing games on the Internet have naturally been part of their lives. Moreover, they have been able to access the Internet rather readily through PC rooms and photonic networks scattered throughout every section of Korea [3].

As the use and functions of the Internet have increased and expanded, there have been rising voices of concerns over excessive Internet use. In addition, according to a 2010 survey by the Korea National Information Society Agency, 5.8% of Korean adults and 12.4% of adolescents are addicted to the Internet. In particular, 3.1% of adolescents are high-risk users, a number about four times higher than that for adults, of whom 0.7% are considered high risk [3]. As Internet addiction among adolescents has become a very important societal issue, studies related to its impacts on their health have been conducted [4-7]. As a result, we know that Internet addiction poses serious problems among adolescents in terms of education, mental health, and social skills, just as alcohol addiction and drug abuse would do. Internet addiction is closely related to both mental health problems such as anxiety, depression, and suicidal accident, as well as physical health problems such as weight gain, headache, and musculoskeletal disease [4-7].

On the one hand, Internet using time has a close relationship with Internet addiction, and the longer the Internet using time, the more risk there is to be addicted to the Internet [8,9]; therefore, it is assumed that the risk

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of secondary health problems would increase. Researchers that studied relationship between Internet use and adolescent health both in and outside of Korea have concentrated on the effect Internet addiction or increased Internet using time has on adolescent health [5-9]; however, the effect of infrequent use of the Internet has been overlooked. It is difficult to claim that no or infrequent use of the Internet is a risk factor for deteriorating adolescent health. However, based on previous studies, which reported that economic poverty and maladjustment to peer culture act as barriers to Internet use, it is easy to assume that adolescents who do not use the Internet as much as others could have a different health status compared to their peers [10]. However, there is, to my knowledge, no study about these associations except Belanger and his colleagues' study [10]. They reported U-shaped nonlinear association between Internet using time and adolescent's depression level, and claimed that adolescents who use the Internet excessively or infrequently compared to their peers are a high-risk group in terms of health. However, their study has some limitations because there was no consideration of the purpose of Internet use; rather, it considered total Internet using time, so the authors suggested using caution when dissecting the results [10]. The purposes for which adolescents use the Internet can largely be categorized as relationship formation, entertainment, and study. Unlike relationship formation or entertainment purposes, the more adolescents use the Internet for study purposes, the better their relationships with parents and teachers [11]. The study further claims that using the internet for study purposes decreases total Internet using time. Therefore, considering the results of previous studies, which stated that parent-child relationships and teacher-student relationships have a close relationship with adolescent health risk behavior and mental health, Internet use for educational purposes could show a positive relationship with health status, unlike using the Internet for non-educational purposes [12,13]. Thus, when observing total hours of Internet use and its relationship with adolescents' health status without considering the purpose of Internet use, different directional relationships could be adulterated and may reduce the validity of the result.

In the case of Korea, since almost all adolescents frequently use the Internet [4], it is necessary to examine how much relevance Internet using time has to health level, and how the health status of adolescents who use the Internet infrequently or not at all differs from their peer group. For this reason, hours of use for educational purpose and non-educational purposes need to be differentiated and be carefully observed. We used the Korea Youth Risk Behavior Web-based Survey (KYRBWS), a nationally representative survey on adolescents' health, to observe the relationship mentioned above. This Internet-related survey has been performed since 2008, but only the total hours of Internet use were investigated in 2008, and only the hours of Internet for non-educational purposes (excluding educational purposes) were investigated in 2009.

This research was performed using the 2009 KYRBWS data to observe carefully what relationship Internet using time for non-educational purposes has with adolescents' health status and to confirm how health status differs between Internet users and non-users.

METHODS

The primitive data of the fifth KYRBWS (2009), conducted by the Korea Centers for Disease Control and Prevention, was used for analysis. The KYRBWS is an anonymous, Internet-based, self-administered structured question-naire intended to investigate health-risk behaviors to provide evidence for adolescent health-promotion policies every year since 2005. The KYRBWS is administered to a nationally representative sample of middle- and high-school students using a complex sampling design involving stratification, clustering, and multistage sampling. In 2009, this investigation was done based on 80 000 targets, and the participation rate was 97.6% [14].

Internet using time for non-educational purposes was recalculated based on daily average hours of non-educational Internet use on weekdays and weekends for the past 30 days. The result was calculated by multiplying the average weekday hour by five, and the average weekend hour by two, adding both numbers together, and then dividing by seven. Respondents were groups into four categories based on the average daily hours of Internet use for non-educational purposes: non-Internet users (NIUs), occasional Internet users (OIUs), moderate Internet users (MIUs), and heavy Internet users (HIUs). NIUs were defined as those who never used the Internet for non-educational purposes during the previous 30 days; OIUs used the Internet less than 1 hour per day; MIUs used the Internet for more than 1 hour but less than 2 hours per day; and HIUs used the Internet for more than 2 hours per day.

Based on previous research, we selected socio-demographic variables that have been associated with adolescents' Internet use and can affect their health

status [5-7,15]. Those variables were gender (boy, girl), residing region (large city, small city, rural area), type of school (middle school, general high school, vocational high school), subjective academic performance status (upper, middle, lower), subjective economic status (upper, middle, lower), family affluence level (upper, middle, lower), presence of parents (both, single father or mother, parentless), and whether the family lives together (yes, no). The family affluence level was calculated for each person on the basis of the respondent's response to the four items and was assigned one of the three family affluence scale scores, that is, lower (0-2), middle (3-5), and upper (6-9) [14].

Variables related to adolescents' health status were divided into three domains: health risk behavior, mental health, and physical health. For this purpose, we selected health-related variables whose association with Internet addiction had been reported by previous studies because of a failing to find adolescent health problems reported as being associated with amount of Internet use [16,17]. As a result, eight indices of health risk behavior were included: current smoking rate, current drinking rate, experience rate of drug abuse, experience rate of sexual intercourse, and four physical inactivity indices. The non-practicing rate for vigorous physical activity (PA) is defined as the proportion of subjects who did not practice vigorous PA (i.e., the subject is out of breath many times and the subject sweats all over the body) for more than 20 minutes per day and for more than three days a week. The non-practicing rate for moderate PA is defined as the proportion of subjects who did not practiced moderate PA (i.e., playing ping-pong, lifting light-weight objects) for more than 30 minutes per day and for more than five days a week. Sedentary behaviors were investigated for weekdays and weekends and divided into 3 hours less and 3 hours more respectively.

The following items are included in mental health status: perceived stress rate, depression rate, experience rate of suicidal ideation, and experience rate of attempted suicide [18,19]. For physical health status, the following items are included: perceived poor health rate, obesity rate, and prevalence of four diseases most common in Korean adolescents-atopic dermatitis, allergic rhinitis, asthma, and gastritis [10]. For obesity, body mass index was obtained using self-reported height and weight, and if the value was above 25, or the 95th percentile as retrieved from the same age group on the Korea infant adolescent growth table, then the subject was categorized as obese [14].

Considering KYRBWS with complex sampling design, design-based analysis was used for analysis [20]. To consider the distribution of Internet using time for non-educational purposes according to sociodemographic variables, frequency and weighted proportion were suggested and statistical significance was assessed using a chi-square test. The associations between Internet using time for non-educational purposes, health risk behavior, and mental and physical health were analyzed by stratifying boys and girls, considering differences in health status for both genders. To assess these associations after controlling for possible confounding effects, we performed multiple logistic regression analysis using Internet using time for non-educational purposes as an independent variable and each health-related variable as a dependent variable. PA, residing region, type of school, subjective academic performance status, subjective economic status, presence of parents, and whether family lives together were used as covariates, and for the other variables, sedentary behavior on weekdays and weekends was added to the covariates. Belanger et al. [10] used MIUs, the group to which most adolescent belonged as a reference group, but we used OIUs as a reference group because most of our adolescents belonged to it. Logistic regression analysis results were suggested using the odds ratio (OR) and 95% confidence interval (CI), and if the 95% CI didn't include 1 (null value), it was judged to be statistically significant. All analysis used the svy command of the STATA version 11.0 (Stata Corp., College Station, TX, USA) program and the statistical significance level was 0.05.

RESULTS

The average of Internet using time for non-educational purposes was as follows: total 31.3 ± 28.9 minutes, boys 32.9 ± 31.2 minutes, girls 29.6 ± 25.1 minutes (supporting data not provided). The distribution of the four groups was as follows: NIUs 17.4%, OIUs 68.1%, MIUs 12.7%, and HIUs 1.8%.

The Internet using time for non-educational purposes was statistically significant for gender, residing region, type of school, subjective academic performance status, subjective economic status, family affluence level, presence of parents, and whether family lives together ($p<0.01$) (Table 1). Compared to girls, more boys belonged were NIUs or HIUs. Among those who lived in rural areas, compared to large or small cities, more adolescents were NIUs or HIUs. For type of school, the proportions of NIUs and HIUs were highest for general high-school students, middle-school students, and

Table 1. Sociodemographic characteristics and internet using time

Sociodemographic variables	Total		NIU		OIU		MIU		HIU		*p*-value[2]
	n	%[1]	n	%	n	%	n	%	n	%	
Gender											
Boy	39 612	100.0	8102	20.6	24 667	62.7	5911	14.4	932	2.3	<0.001
Girl	35 454	100.0	5094	14.0	25 939	74.2	4004	10.7	417	1.1	
Residing region											
Rural area	9372	100.0	1815	19.4	5865	62.4	1478	15.9	214	2.3	<0.001
Small city	26 407	100.0	4816	17.9	17 742	68.4	3381	12.0	468	1.7	
Large city	39 287	100.0	6565	17.0	26 999	68.4	5056	12.9	667	1.7	
Type of school											
Middle school	38 409	100.0	6931	17.9	25 697	67.7	5088	12.7	693	1.7	<0.001
General high school	27 380	100.0	4200	14.9	19 936	73.8	2919	10.1	325	1.2	
Vocational high school	9277	100.0	2065	23.4	4973	52.2	1908	20.6	331	3.8	
Subjective academic performance status											
Upper	25 995	100.0	3934	15.3	19 134	73.8	2586	9.5	341	1.4	<0.001
Middle	20 219	100.0	3289	16.3	14 226	71.1	2473	11.5	231	1.1	
Lower	28 852	100.0	5973	20.3	17 246	60.7	4856	16.4	777	2.6	
Subjective economic status											
Upper	20 250	100.0	3883	18.8	14 115	70.4	1950	9.3	302	1.5	<0.001
Middle	35 449	100.0	5590	15.6	24 822	70.7	4523	12.3	514	1.4	
Lower	19 367	100.0	3723	19.5	11 669	60.5	3442	17.2	533	2.8	
Family affluence score											
Upper	22 676	100.0	3883	16.9	14 115	70.6	1950	10.7	302	1.8	<0.001
Middle	42 299	100.0	5590	16.3	24 822	69.1	4523	13.0	514	1.6	
Lower	10 091	100.0	3723	24.0	11 669	57.3	3442	16.4	533	2.4	
Presence of parents											
Both	61 334	100.0	10 112	16.4	42 922	70.7	7399	11.5	901	1.4	<0.001
Fatherless or motherless	9969	100.0	1908	19.4	5809	57.6	1933	19.6	319	3.3	
Parentless	3763	100.0	1176	32.9	1875	48.9	583	14.6	129	3.6	
Whether the family lives together											
Yes	71 138	100.0	12 089	16.9	48 287	68.6	9497	12.8	1265	1.7	<0.001
No	3928	100.0	1107	30.0	2319	57.2	418	10.7	84	2.1	
Total	75 066	100.0	13 196	17.4	50 606	68.1	9915	12.7	1349	1.8	

NIU, no Internet user; OIU, occasionally Internet user (<1 h/d); MIU, moderate Internet user (1≤ and <2 h/d); HIU, heavy Internet user (≥2 h/d).
[1]Weighted percentage.
[2]*p*-value calculated by chi-square test.

Table 2. Health risk behaviors and internet using time by gender

Health risk behaviors	Boys					Girls				
	NIU (%[1])	OIU (%)	MIU (%)	HIU (%)	*p*-value[2]	NIU (%)	OIU (%)	MIU (%)	HIU (%)	*p*-value
Current smoking rate	24.2	13.9	20.9	32.1	0.26	13.0	6.0	12.4	17.1	<0.001
Current drinking rate	28.7	20.9	26.9	35.2	<0.001	21.3	16.6	24.0	28.1	<0.001
Experience rate of drug abuse	5.3	1.1	1.2	5.9	<0.001	3.0	0.8	1.4	3.8	<0.001
Experience rate of sexual intercourse	11.3	5.2	7.7	15.9	<0.001	5.0	2.4	4.0	7.3	<0.001
Non-practicing rate of vigorous PA (<3 d/wk)	56.6	55.5	60.7	66.2	<0.001	77.9	82.0	83.3	83.2	<0.001
Non-practicing rate of moderate PA (<5 d/wk)	83.6	85.2	86.3	85.9	0.03	92.5	94.2	94.8	97.3	<0.001
Sedentary behavior in weekday (≥3 h/d)	24.5	15.0	52.3	73.3	<0.001	24.2	19.3	60.5	84.5	<0.001
Sedentary behavior in weekend (≥3 h/d)	36.8	36.5	80.0	82.2	<0.001	37.3	41.9	84.0	86.8	<0.001

NIU, no Internet user; OIU, occasionally Internet user (<1 h/d); MIU, moderate Internet user (≥ 1 and <2 h/d); HIU, heavy Internet user (≥2 h/d); PA, physical activity.
[1]Weighted percentage.
[2]*p*-value calculated by chi-square test.

vocational high-school students, in that order. For subjective economic status and the family affluence level, the proportions of NIUs and HIUs were highest for lower, upper and middle, in that order. On the other hand, for subjective academic performance status, the proportions of NIUs and HIUs were highest in the lower status. Among those who were parentless or did not live with their families, the proportions of NIUs and HIUs were high.

The distributions of health status according to Internet

Table 3. Mental health status and internet using time by gender

Mental health status	Boys					Girls				
	NIU (%[1])	OIU (%)	MIU (%)	HIU (%)	*p*-value[2]	NIU (%)	OIU (%)	MIU (%)	HIU (%)	*p*-value
Perceived stress rate	38.8	35.3	41.2	51.9	<0.001	51.2	48.2	58.7	58.7	<0.001
Depression rate	35.8	30.2	32.1	40.0	<0.001	46.4	41.6	51.4	61.3	<0.001
Experience rate of suicide ideation	16.7	13.6	18.0	26.4	<0.001	25.8	21.8	30.9	43.3	<0.001
Experience rate of attempted suicide	4.9	2.4	4.1	10.0	<0.001	7.3	5.2	8.6	13.9	<0.001

NIU, no Internet user; OIU, occasionally Internet user (<1 h/d); MIU, moderate Internet user (1≤ and <2 h/d); HIU, heavy Internet user (≥2 h/d).
[1]Weighted percentage.
[2]*p*-value calculated by chi-square test.

Table 4. Physical health status and internet using time by gender

Physical health status	Boys					Girls				
	NIU (%[1])	OIU (%)	MIU (%)	HIU (%)	*p*-value[2]	NIU (%)	OIU (%)	MIU (%)	HIU (%)	*p*-value
Perceived poor health rate	30.6	28.8	37.7	48.1	<0.001	62.1	61.0	55.0	50.9	<0.001
Obesity rate	11.7	11.2	14.5	28.7	<0.001	5.1	5.2	7.4	7.6	<0.001
Atopic dermatitis-accompanying rate	8.8	9.5	9.9	5.3	0.04	12.4	12.3	13.9	13.1	0.12
Rhinitis-accompanying rate	20.2	25.7	22.9	20.3	<0.001	21.2	23.2	23.0	22.4	0.13
Asthma-accompanying rate	4.4	3.6	3.6	5.4	0.02	3.0	2.5	3.0	3.2	0.12
Gastritis-accompanying rate	3.4	2.9	3.4	5.9	<0.001	8.4	7.5	8.5	10.2	0.08

NIU, no Internet user; OIU, occasionally Internet user (<1 h/d); MIU, moderate Internet user (1≤ and <2 h/d); HIU, heavy Internet user (≥2 h/d).
[1]Weighted percentage.
[2]*p*-value calculated by chi-square test.

using time for non-educational purposes are as follows. The Internet using time for non-educational purposes was significantly associated with health risk behaviors in both genders ($p<0.001$) (Table 2). In boys, current drinking rate, experience rate of drug abuse and sexual intercourse rate were significantly increased in the order of OIUs, MIUs, NIUs, and HIUs; current smoking rate showed the same tendency but there was no statistical significance. In girls, current smoking rate, experience rate of drug abuse and sexual intercourse were significantly increased in the order of OIUs, MIUs, NIUs, and HIUs, but current drinking rate was increased in the order of OIUs, NIUs, MIUs, and HIUs. For non-practicing rate of vigorous PA, the rates for NIUs and OIUs were quite similar and lower than the rates of the others in boys, but the rate for NIUs was less than the rates for the others in girls. For non-practicing rate of moderate PA, the rate for NIUs was lower than those for the others in boys, but in girls, the rates increased with increased Internet using time. The sedentary behavior rate for more than three hours on weekdays was high in the order of OIUs, NIUs, MIUs, and HIUs for both genders, and on the weekends, the same tendency was observed in boys but it increased with an increased Internet using time in girls.

Mental health status distribution according to the Internet using time for non-educational purposes is as follows. Significant associations were observed between mental health status and Internet using time in both genders ($p<0.001$) (Table 3). For male students, perceived stress rate and experience rate of suicide ideation were highest in the order of OIUs, NIUs, MIUs, and HIUs. For female students, perceived stress rate, depression rate, experience rate of suicide ideation and attempted suicide were increased in the order of OIUs, NIUs, and HIUs.

Physical health status distribution according to Internet using time for non-educational purposes is as follows (Table 4). Perceived poor health rate and obesity rate were significantly increased in both genders in the order of OIUs, NIUs, MIUs, and HIUs ($p<0.001$), and significant associations with the disease-accompanying rates were observed in boys only ($p<0.05$). Asthma- and gastritis-accompanying rates were highest in the order of OIUs, NIUs, MIUs, and HIUs, but atopic dermatitis- and allergic rhinitis-accompanying rate were significantly high in NIUs and HIUs.

In order to understand the association between health-related characteristics and Internet using time for non-educational purposes, multiple logistic regression analysis was performed (Tables 5 and 6). For both genders, estimated ORs of NIUs, MIUs and HIUs contrast to OIUs were significantly greater than 1, and the OR estimates increased in order of MIUs, NIUs, HIUs in current smoking rate, current drinking rate, and experience rate of sexual intercourse. These showed U-

Table 5. The association between internet using time for non-educational purpose and health status by multiple logistic analyses in boys

Health status index	Unadjusted				Adjusted[1]			
	NIU	OIU[2]	MIU	HIU	NIU	OIU	MIU	HIU
	OR (95% CI)	OR	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR	OR (95% CI)	OR (95% CI)
Current smoking	1.99 (1.83, 2.16)	1.00	1.64 (1.49, 1.80)	2.94 (2.48, 3.50)	1.64 (1.50, 1.80)	1.00	1.21 (1.08, 1.35)	1.93 (1.57, 2.37)
Current drinking	1.52 (1.40, 1.65)	1.00	1.39 (1.28, 1.51)	2.05 (1.72, 2.45)	1.38 (1.27, 1.50)	1.00	1.18 (1.07, 1.30)	1.61 (1.33, 1.96)
Experience rate of drug abuse	4.82 (3.94, 5.89)	1.00	1.06 (0.78, 1.44)	5.39 (3.72, 7.80)	4.18 (3.38, 5.17)	1.00	1.02 (0.74, 1.40)	4.08 (2.71, 6.15)
Experience rate of sexual intercourse	2.31 (2.06, 2.60)	1.00	1.51 (1.31, 1.73)	3.45 (2.67, 4.45)	1.93 (1.71, 2.17)	1.00	1.29 (1.09, 1.52)	2.37 (1.78, 3.16)
Non-practicing rate of vigorous PA (<3 d/wk)	1.04 (0.98, 1.11)	1.00	1.24 (1.15, 1.33)	1.57 (1.34, 1.84)	1.06 (0.99, 1.13)	1.00	1.23 (1.14, 1.32)	1.55 (1.31, 1.82)
Non-practicing rate of moderate PA (<5 d/wk)	0.88 (0.81, 0.97)	1.00	1.09 (0.99, 1.20)	1.05 (0.83, 1.35)	0.90 (0.83, 0.99)	1.00	1.10 (0.99, 1.21)	1.08 (0.85, 1.38)
Sedentary behavior in weekday (≥3 h/d)	1.84 (1.70, 1.99)	1.00	6.23 (5.72, 6.79)	15.62 (12.54, 19.45)	1.66 (1.53, 1.80)	1.00	5.37 (4.91, 5.87)	13.29 (10.75, 16.44)
Sedentary behavior in weekend (≥3 h/d)	1.01 (0.94, 1.09)	1.00	6.96 (6.39, 7.59)	8.06 (6.44, 10.09)	0.97 (0.90, 1.04)	1.00	6.41 (5.88, 6.99)	7.33 (5.88, 9.13)
Perceived stress	1.16 (1.08, 1.24)	1.00	1.28 (1.18, 1.39)	1.98 (1.68, 2.33)	1.08 (1.01, 1.16)	1.00	1.12 (1.02, 1.22)	1.55 (1.30, 1.84)
Depression	1.29 (1.20, 1.37)	1.00	1.18 (1.09, 1.28)	1.54 (1.31, 1.81)	1.21 (1.13, 1.30)	1.00	1.11 (1.02, 1.21)	1.33 (1.12, 1.59)
Experience rate of suicide ideation	1.27 (1.17, 1.39)	1.00	1.39 (1.26, 1.54)	2.27 (1.90, 2.71)	1.17 (1.07, 1.28)	1.00	1.22 (1.09, 1.36)	1.80 (1.47, 2.19)
Experience rate of attempted suicide	2.11 (1.82, 2.44)	1.00	1.72 (1.40, 2.11)	4.50 (3.41, 5.93)	1.87 (1.61, 2.18)	1.00	1.51 (1.20, 1.90)	3.41 (2.43, 4.79)
Perceived poor health	1.12 (0.98, 1.29)	1.00	1.61 (1.43, 1.81)	2.45 (1.95, 3.08)	1.03 (0.90, 1.18)	1.00	1.23 (1.07, 1.41)	1.57 (1.22, 2.00)
Obesity	1.06 (0.96, 1.17)	1.00	1.35 (1.21, 1.50)	1.48 (1.18, 1.89)	1.02 (0.93, 1.10)	1.00	1.08 (0.97, 1.21)	1.22 (0.98, 1.52)
Atopic dermatitis-accompanying	0.91 (0.81, 1.03)	1.00	1.05 (0.92, 1.20)	1.33 (1.02, 1.72)	0.93 (0.82, 1.04)	1.00	1.04 (0.90, 1.20)	1.32 (1.01, 1.71)
Rhinitis-accompanying	0.73 (0.68, 0.79)	1.00	0.86 (0.78, 0.94)	0.74 (0.59, 0.92)	0.78 (0.72, 0.85)	1.00	0.94 (0.85, 1.04)	0.82 (0.66, 1.03)
Asthma-accompanying	1.22 (1.05, 1.43)	1.00	0.99 (0.83, 1.19)	1.51 (1.01, 2.26)	1.20 (1.01, 1.43)	1.00	1.03 (0.83, 1.28)	1.49 (0.96, 2.30)
Gastritis-accompanying	1.18 (0.95, 1.46)	1.00	1.18 (0.95, 1.47)	2.09 (1.49, 2.93)	1.13 (0.91, 1.40)	1.00	1.13 (0.87, 1.45)	1.98 (1.38, 2.83)

NIU, no Internet user; OIU, occasionally Internet user (<1 h/d); MIU, moderate Internet user (1≤ and <2 h/d); HIU, heavy Internet user (≥2 h/d); OR, odds ratio; CI, confidence interval; PA, physical activity.

[1]Adjusted for age, residing region, type of school, subjective academic performance status, subjective economic status, presence of parents, whether the family lives together and sedentary behavior in weeks and weekend.

[2]OIU served as a reference group.

Table 6. The association between internet using time for non-educational purpose and health status by multiple logistic analyses in girls

Health status index	Unadjusted				Adjusted[1]			
	NIU	OIU[2]	MIU	HIU	NIU	OIU	MIU	HIU
	OR (95% CI)	OR	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR	OR (95% CI)	OR (95% CI)
Current smoking	2.43 (2.14, 2.77)	1.00	2.31 (1.99, 2.69)	3.37 (2.45, 4.64)	1.95 (1.69, 2.24)	1.00	1.76(1.48, 2.10)	2.31 (1.59, 3.36)
Current drinking	1.36 (1.29, 1.51)	1.00	1.59 (1.41, 1.78)	1.97 (1.50, 2.59)	1.21 (1.10, 1.35)	1.00	1.24 (1.09, 1.42)	1.45 (1.06, 1.98)
Experience rate of drug abuse	3.79 (2.86, 5.02)	1.00	1.78 (1.27, 2.50)	4.87 (2.44, 9.68)	3.22 (2.39, 4.34)	1.00	1.44 (1.01, 2.09)	3.05 (1.49, 6.24)
Experience rate of sexual intercourse	2.17 (1.78, 2.65)	1.00	1.70 (1.23, 2.36)	3.24 (1.86, 5.66)	1.80 (1.46, 2.23)	1.00	1.47 (1.02, 2.10)	2.59 (1.50, 4.45)
Non-practicing rate of vigorous PA (<3 d/wk)	0.77 (0.70, 0.85)	1.00	1.09 (0.98, 1.21)	1.09 (0.73, 1.61)	0.84 (0.76, 0.92)	1.00	1.16 (1.05, 1.29)	1.25 (0.86, 1.83)
Non-practicing rate of moderate PA (<5 d/wk)	0.76 (0.66, 0.88)	1.00	1.12 (0.91, 1.36)	2.22 (1.12, 4.39)	0.81 (0.70, 0.94)	1.00	1.17 (0.96, 1.43)	2.48 (1.27, 4.87)
Sedentary behavior in weekday (≥3 h/d)	1.34 (1.22, 1.47)	1.00	6.42 (5.91, 6.99)	22.79 (16.44, 31.59)	1.19 (1.07, 1.31)	1.00	5.73 (5.24, 6.26)	19.55 (14.13, 27.03)
Sedentary behavior in weekend (≥3 h/d)	0.83 (0.76, 0.90)	1.00	7.28 (6.54, 8.11)	9.12 (6.28, 13.26)	0.79 (0.73, 0.86)	1.00	6.83 (6.13, 7.61)	8.53 (5.87, 12.40)
Perceived stress	1.12 (1.04, 1.21)	1.00	1.52 (1.41, 1.64)	1.99 (1.51, 2.61)	1.08 (1.01, 1.16)	1.00	1.32 (1.21, 1.43)	1.58 (1.18, 2.11)
Depression	1.22 (1.13, 1.31)	1.00	1.49 (1.35, 1.63)	2.23 (1.74, 2.85)	1.15 (1.06, 1.25)	1.00	1.33 (1.20, 1.47)	1.87 (1.43, 2.46)
Experience rate of suicide ideation	1.25 (1.15, 1.37)	1.00	1.60 (1.46, 1.76)	2.74 (2.02, 3.72)	1.15 (1.05, 1.25)	1.00	1.36 (1.23, 1.50)	2.16 (1.55, 3.00)
Experience rate of attempted suicide	1.42 (1.22, 1.64)	1.00	1.70 (1.47, 1.95)	2.91 (2.02, 4.19)	1.23 (1.05, 1.43)	1.00	1.37 (1.18, 1.60)	2.04 (1.41, 2.95)
Perceived poor health	1.10 (0.98, 1.24)	1.00	1.48 (1.30, 1.68)	2.72 (1.94, 3.82)	1.03 (0.91, 1.17)	1.00	1.25 (1.09, 1.43)	2.16 (1.53, 3.05)
Obesity	1.14 (1.02, 1.29)	1.00	1.05 (0.92, 1.20)	1.19 (0.81, 1.75)	1.04 (0.92, 1.16)	1.00	1.05 (0.90, 1.21)	1.07 (0.70, 1.64)
Atopic dermatitis-accompanying	1.00 (0.90, 1.12)	1.00	1.15 (1.03, 1.28)	1.07 (0.75, 1.53)	1.01 (0.90, 1.12)	1.00	1.15 (1.02, 1.29)	1.06 (0.73, 1.54)
Rhinitis-accompanying	0.89 (0.81, 0.97)	1.00	0.99 (0.88, 1.11)	0.95 (0.70, 1.30)	0.92 (0.85, 1.01)	1.00	1.03 (0.92, 1.15)	1.04 (0.76, 1.42)
Asthma-accompanying	1.27 (0.99, 1.52)	1.00	1.23 (0.96, 1.57)	1.29 (0.65, 2.58)	1.14 (0.91, 1.42)	1.00	1.18 (0.89, 1.55)	1.08 (0.52, 2.24)
Gastritis-accompanying	1.13 (0.99, 1.29)	1.00	1.15 (0.97, 1.35)	1.40 (0.92, 2.14)	1.14 (0.99, 1.31)	1.00	1.12 (0.94, 1.35)	1.43 (0.93, 2.17)

NIU, no Internet user; OIU, occasionally Internet user (<1 h/d); MIU, moderate Internet user (1≤ and <2 h/d); HIU, heavy Internet user (≥2 h/d); OR, odds ratio; CI, confidence interval; PA, physical activity.

[1]Adjusted for age, residing region, type of school, subjective academic performance status, subjective economic status, presence of parents, whether the family lives together and sedentary behavior in weeks and weekend.

[2]OIU served as a reference group.

shaped associations. These tendencies were still observed after removing confounding effect such as age, residing region, subjective academic performance status, subjective economic status, presence of parents, whether

family lives together, and sedentary behavior rate on weekdays and weekends. For experience rate of drug abuse, OR estimates for MIUs were not significant in boys, but the same U-shaped associations were still observed in both genders before and after adjusting confounding effects. In boys, the OR estimates for non-practicing rate of vigorous PA were significantly higher than 1 in both MIUs and HIUs before and after adjustment, and in girls, the OR estimate was significantly lower than 1 in NIUs before and after adjustment. However, we could not observe any distinct linear or nonlinear associations. OR estimates of non-practicing rate of moderate PA for NIUs were significantly lower than 1 in both genders, but those for HIUs were significantly higher than 1 only in girls, so a little linear associations was observed in girls. The OR estimates of sedentary behavior rate on weekdays, in both genders, were significantly higher than 1 and showed U-shaped association in both models. On the other hand, OR estimates for the weekends for NIUs were significantly lower than 1 in girls, and a linear-shaped association was observed.

For mental health status, in both genders, OR estimates of perceived stress rate, depression rate, experience rate of suicide ideation and experience rate of attempted suicide were all significantly higher than 1 and showed a U-shape (depression rate, experience rate of attempted suicide) or J-shape (perceived stress rate, experience rate of suicide ideation) associations. These associations were still observed after controlling confounding effects.

For physical health status, OR estimates of perceived poor health rate were significantly higher than 1 in MIUs and HIUs but U or J-shaped association was not observed in both genders. OR estimates of obesity rate were not significantly different, with null values in both genders. Among accompanying rates of common disease, for boys, OR estimates of allergic rhinitis in all three groups were significantly lower than 1 before adjustment, but were significant only in NIUs after adjustment. For atopic dermatitis and gastritis, for boys, OR estimates for HIUs were higher than 1 before and after adjustment. In the case of asthma, OR estimates for NIUs and HIUs were significantly higher than 1 before adjustment, but the OR estimate for HIUs lost its significance after adjustment. There were no variables that were significant among girls.

DISCUSSION

Through this research, we provided evidence of U- or J-shaped association between the Internet using time for non-educational purposes and some domains of health status in Korean adolescents. That is to say, those who use the Internet excessively or rarely compared to their peers for relationship formation or entertainment, were seen to be at increased health risk. These nonlinear associations were observed in health risk behaviors including current smoking, current drinking, experience rate of drug abuse and sexual intercourse, and also observed in mental health status, including perceived stress rate, depression rate, experience rate of suicidal ideation, and attempted suicide.

No studies have reported these nonlinear, U-shaped associations between Internet using time and adolescents' health status except for that of Belanger et al. [10]. They investigated Internet use's impact on adolescents' health status, including perceived poor health, overweight, back pain, headache, insufficient sleep quantity, and depression, controlling for various confounding effects. As a result, they reported that significant U-shaped associations were observed in depression for both genders, and the risk of back pain was higher in NIUs than MIUs for boys. The differences between the their study and ours are, first of all, Belanger and his colleagues used total amount of internet use without considering the purpose of the Internet use, whereas our study considered amount of Internet use only for non-educational purposes. Therefore, the limitation of our study comes from the fact that one cannot grasp what kind of association may exist for total amount of Internet use, and it is necessary to translate our result carefully. It is generally agreed, as in several previous studies, that the longer the total Internet using time, the greater the danger of Internet addiction and adolescent health is aggravated [4-8]. On the other hand, a contradictory report states that if the Internet is used for educational purposes, then as the amount of use increases, the parent-child and teacher-student relationships, which are positively associated with mental health level and some health risk behaviors, get better [11-13]. This implies that other types of association might appear between Internet using time and health status depending on the purpose of the use, and if other types of association exist, this could work as an obstacle in grasping the association between total Internet using time and health status. Unfortunately, our study was unable to find an association for total Internet using time, but by limiting our study to non-educational purposes only, there was a

possibility to observe these associations with health status rather precisely. Second, Belanger and his colleagues used MIUs as a reference group in the logistic model, but we used OIUs instead. This is from the result that stated, out of the four groups that were categorized according to Internet using time for non-educational purposes, OIUs were the largest group (68.1%). Because of this, it is possible to compare the risk of those who use the Internet infrequently or excessively with the risk of most of their peers. Finally, there is a high possibility that although subjects were going to be categorized as MIUs in our study, a considerable number of them were categorized as OIUs in the Belanger study by eliminating Internet use for educational purposes. Therefore, due to these differences, comparing the results of these studies carelessly may not be right, but they have one important implication in common: U- or J-shaped association was observed between Internet using time and adolescent health.

Similar nonlinear association related to adolescent health has been reported from drinking or marijuana use, which could induce an addiction problem, but not in terms of Internet use [21,22]. Vanheusden et al. [21] reported that drinking showed U-shaped association with internalized problems, and J-shaped association with violent behaviors, and O' Donnell et al. [22] reported U-shaped association between drinking and depression symptoms. Moreover, Suris et al. [23] reported U-shaped association between use of marijuana and socialization technique or physical activities. Unfortunately, no definitive answer has been given to the cause of this association and it has been still remained a controversy [21-24].

If the subject does not use the Internet at all for non-educational purposes, the phenomenon of the risk of health risk behavior and mental health risk increase needs to be interpreted with discretion. It is not desirable to conclude that not using the Internet for non-educational purposes itself is the risk factor that aggravates adolescents' health status. In order to understand the aforementioned phenomenon, it is necessary to consider, first and foremost, that the Internet is an arena adolescents use for various purposes, including studying, playing, and enjoying hobbies, and is the main media through which the subjects share and spread information with each other [25,26]. This suggests that adolescent who do not use the Internet except for educational purposes have characteristics different from their peers, and these characteristics seemed to have either indirect or direct effects on health status. Belanger and his colleagues considered isolation from peers' cultural environment and poverty as possible explanations for these characteristics, and tried to observe the association between Internet using time for non-educational purposes and adolescent health after removing confounding factors' effect. Thus, they used as many covariates as possible in multivariate analysis, including age, academic grades, socioeconomic level, physical activity, and presence of chronic conditions [10]. To inquire whether or not the association disappears after removing confounding effects, and to grasp the cause of the association, we tried to consider all variables available in the KYRBWS data as confounders and selected variables related to both Internet use and adolescent health. Through the literature review, we selected socio-ecologic factors (i.e., age, sex, socioeconomic level), family factors (i.e., presence of parents, whether or not family lives together, parents' manner of bringing up their children, supervision and support), school factors (i.e., type of school, academic grades, relationship with friends, peer culture, adaption to school life) [7,12,13,27-30]. Finally, we selected age, sex, presence of parents, whether or not family lives together, type of school, subjective academic performance status, and subjective economic status as confounders. In addition, since amount of Internet use and sedentary behavior show close association, in general, sedentary behavior on weekdays and weekends were added [17]. Even after removing confounding effects selected using multivariate analysis, the J- or U-shaped association was still observed. As a consequence of stratified analysis using type of school, subjective economic level, presence of parents, and whether or not family lives together (supporting data not provided), the same tendency was observed in each stratum. Thus, these associations do not seem to have come from differences in accessibility due to poverty or other socio-ecological factors, and other factors such as being unable to adapt to peer culture, which we were not able to consider in this study, seem to work. Therefore, it is necessary to investigate these causes through further studies.

The strength of this study is that we used KYRBWS data, which were representative and confirmed to be valid, and that this is the first study providing evidence of U- or J-shaped association between Internet using time for non-educational purposes and adolescents' health status in Korea. Despite these findings, some limitations still exist. First, in terms of Internet using time, we used only time for non-educational purposes and did not consider total Internet using time. Thus,

expanding the result of this study to total Internet using time and interpreting the result is not desirable, and the result should absolutely be limited to only Internet using time for non-educational purposes. Hereafter, in terms of total Internet using time, which was unable to be considered in this study, follow-up research is urgently needed to see whether or not U-shaped or J-shaped association is observed, and whether or not there are differences in types of association of health status according to purpose of use. Second, due to the limited variables available in the KYRBWS data, it was not possible to investigate precisely the causes of nonlinear associations observed according to Internet using time. Although Internet use for non-educational purposes may not be a direct risk factor for adolescent health, it may be a proxy index with which other factors participate in complex ways, and it was possible to observe that not only excessive Internet users but also non-Internet users were subjects that deserve attention from the public health field. Third, this study is a cross-sectional study, so direction of associations observed through this study cannot be defined clearly. In the case of health risk behavior, it would be correct to claim that health risk behavior and Internet use affect each other, but in the case of mental health status, like depression, it is confusing because it is not clear whether the subjects use the Internet inappropriately because they are depressed, or whether the use of the Internet makes them depressed. Fourth, the results of this study were based on schools and their students, so adolescents who do not go to school are excluded from the list of subjects for investigation. There is a possibility that adolescents who do not go to school might have different Internet use-related conditions or health status, and this fact needs to be considered in interpretation of the results of this study. Finally, variables related to accompanying status of common disease use self-reported results, which might decrease the accuracy.

It is very important to know that Internet using time for non-educational purposes shows U- or J-shaped nonlinear association with adolescents' health status and that different health status is observed between NIUs and OIUs, the group to which most peers belong, in terms of public health concerns. Until now, many researchers and public health providers have paid a lot of attention to adolescents who are addicted to the Internet or who use the Internet excessively as risk groups for potential health problems. However, from what has been said above, it should be concluded that in the future, for public health studies and policies concerning adolescent Internet problems, both Internet addiction and Internet using time need to be considered, and when assessing high-risk group related to Internet use, those who do not use the Internet for non-educational purposes need to be considered. In addition, it remains to be seen why the nonlinear association was observed between Internet using time for non-educational purposes and adolescents' health status, especially for health risk behavior and mental health status.

CONFLICT OF INTEREST

The authors have no conflicts of interest with the material presented in this paper.

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