

## Original Article



# Associations of Caffeinated Beverage Consumption and Screen Time with Excessive Daytime Sleepiness in Korean High School Students

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## ABSTRACT

The present study investigated caffeinated beverage consumption and screen time in the association with excessive daytime sleepiness (EDS) and sleep duration. We conducted a cross-sectional study including 249 Korean male high school students. These participants responded to a questionnaire inquiring the information on lifestyle factors, consumption of caffeinated beverages, time spent for screen media, and sleep duration as well as to the Epworth Sleepiness Scale (ESS) questionnaire. EDS was defined as ESS scores of 9 or greater. Students with EDS consumed greater amount of chocolate/cocoa drinks and spent longer time for a TV and a mobile phone than those without EDS ( $p < 0.05$ ). In addition, students with short sleep ( $\leq 6$  hours) consumed greater amount of coffee than others whereas students with long sleep ( $> 8$  hours) consumed greater amount of chocolate/cocoa drinks than others ( $p < 0.05$ ). Screen time did not differ according to the categories of sleep duration. Although these findings do not support causal relationships, they suggest that screen time is associated with EDS, but not with sleep duration, and that consumption of certain types of caffeinated beverages is associated with EDS and sleep duration. Adolescents may need to reduce screen time and caffeine consumption to improve sleep quality and avoid daytime sleepiness.

**Keywords:** Caffeinated beverage; Screen time; Excessive daytime sleepiness; Sleep duration

## INTRODUCTION

Excessive daytime sleepiness (EDS) is characterized by difficulty maintaining wakefulness and an increased tendency falling asleep during the day even after a full night's sleep [1]. EDS contributes to decreased ability to concentrate, in particular, impairs academic performance in adolescents [2]. One of factors causing EDS is excessive screen time, which includes time spent for screen media such as TV, DVD movies, a computer, or screen games. Recently, mobile phone use was also considered an additional part of screen media and associated with EDS [3]. Adolescents who used a mobile phone after lights out almost daily were likely to have EDS and sleep disturbances [4]. Another factor associated with EDS may be excessive caffeine consumption. Excessive caffeine consumption results in nervousness, excitement, agitation, and arousal. Adolescents are more sensitive to caffeine consumption partly due to lower ability to degrade caffeine in the body than adults are. Thus, it has been suggested

### Conflict of Interest

The authors declare that they have no competing interests.

that frequent consumption of caffeinated beverages including coffees and energy drinks interferes sleep at night leading to EDS in adolescents [5]. However, data are still limited on the association between caffeinated beverage consumption and EDS in adolescents. Furthermore, no study has examined both caffeinated beverage consumption and screen time in the association with EDS in adolescents while there is one study showing that both factors are associated with short sleep duration [6].

In a cross-sectional study, we evaluated whether caffeinated beverage consumption and screen time are associated with EDS and sleep duration in Korean male adolescents who were high school students.

## MATERIALS AND METHODS

### Study participants and procedures

Study participants were students who attended a high school located in Mapo-gu, Seoul, Republic of Korea, in April 2014. A questionnaire, which did not inquire any information to identify a specific individual, was distributed to 368 students, and 82% of them were willing to complete the questionnaire. Among these 301 students, because only 52 were female students, we included data of 249 male students in analyses for the present study.

The questionnaire inquired the information of caffeinated beverage consumption, screen time, sleep duration, and daytime sleepiness as well as other characteristics including age, experience of smoking or alcohol drinking, regular physical activity, weight loss attempts, and experience of working for making money. Detailed questions regarding caffeinated beverage consumption consisted of average amount and frequency of drinking occasion for major caffeinated beverages including coffees, teas, soft drinks, energy drinks, and chocolate/cocoa drinks. Questions regarding screen time comprised of time spent and frequency for specific screen media including TV, DVD movies, a computer, a mobile phone, and screen games. Daytime sleepiness was asked by using the Epworth Sleepiness Scale (ESS) questionnaire, which inquires frequency of daytime sleepiness while reading and sitting, watching TV, sitting inactive in a public place, sitting and talking to someone, traveling as a passenger in a car, resting in the afternoon, sitting quietly after a lunch, or being in a car stopped in traffic. The ESS scores range between 0 and 24, and EDS is defined as having scores of 9 or greater [7].

### Statistical analysis

Descriptive statistics for characteristics of study participants were calculated. Sleep duration was classified into 4 groups;  $\leq 6.0$  hours, 6.1–7.0 hours, 7.1–8.0 hours, and  $> 8.0$  hours, and the ESS scores was classified into 3 groups;  $\leq 6$ , 7–8, and  $\geq 9$ . Across these groups, characteristics of the study participants were compared. For continuous data, the analysis of variance (ANOVA) F test was used to assess differences in the means across the groups. For the post-hoc test of the ANOVA, Scheffé's method was used. Statistical significance was set at 0.05 (2-sided). The SAS (SAS 9.1; SAS Institute, Cary, NC, USA) program was used to conduct statistical analyses.

## RESULTS

**Table 1** shows characteristics of the study participants. Most of them had never experienced smoking, alcohol drinking, weight loss attempts, and working for making money, but had

**Table 1.** Characteristics of 249 Korean male high school students

Characteristics		No. of students (%) or mean $\pm$ SD
Age, yr	17	133 (53.4)
	18	60 (24.1)
	19	56 (22.5)
Experience of smoking	No	232 (93.2)
	Yes	17 (6.8)
Experience of alcohol drinking	No	214 (85.9)
	Yes	35 (14.1)
Regular physical activity	No	77 (30.9)
	Yes	172 (69.1)
Weight loss attempts	No	202 (81.1)
	Yes	47 (18.9)
Experience of working for making money	No	193 (77.5)
	Yes	56 (22.5)
Caffeinated beverage consumption	No	18 (7.2)
	Yes	231 (92.8)
Consumption of specific caffeinated beverages, cup/day	Coffee	0.4 $\pm$ 0.4
	Tea	0.3 $\pm$ 0.6
	Soft drink	0.4 $\pm$ 0.3
	Energy drink	0.2 $\pm$ 0.3
	Chocolate/cocoa drink	0.2 $\pm$ 0.6
Having screen time	No	7 (2.8)
	Yes	242 (97.2)
Time spent for specific screen media, hr/day	TV	0.7 $\pm$ 0.7
	DVD movies	0.3 $\pm$ 0.6
	Computer	1.3 $\pm$ 0.7
	Mobile phone	1.5 $\pm$ 0.7
	Screen games	0.5 $\pm$ 0.7
Average screen time, hr/day		4.4 $\pm$ 1.9
Average sleep duration, hr/day		6.9 $\pm$ 1.1
ESS scores	$\leq$ 6	157 (63.0)
	7–8	44 (17.7)
	$\geq$ 9	48 (19.3)

SD, standard deviation; ESS, Epworth Sleepiness Scale.

consumed caffeinated beverages and had screen time. Among major caffeinated beverages consumed, consumption of coffee and soft drinks were greater than that of the other types of beverages. Among major screen media, time spent for a computer and a mobile phone was longer than time spent for the others. Average screen time was 4.4 hours per day while average sleep duration was 6.9 hours per day. About 19% were examined to have EDS based on the ESS scores.

In **Table 2**, consumption of specific caffeinated beverages and time spent for specific screen media were compared according to the categories of sleep duration. Students with short sleep ( $\leq$  6 hours) consumed greater amount of coffee than others did whereas those with long sleep ( $>$  8 hours) consumed greater amount of chocolate/cocoa drinks than others did ( $p < 0.05$ ). However, total screen time and time of specific screen media did not differ according to the categories of sleep duration.

In **Table 3**, consumption of specific caffeinated beverages and time spent for specific screen media were compared according to the categories of the ESS scores. Students with EDS who had the ESS scores of 9 or higher consumed greater amount of chocolate/cocoa drinks and spent longer time for a TV and a mobile phone than those without EDS ( $p < 0.05$ ). Thus, students with EDS spent about 5 hours for all screen media whereas those without EDS spent about 4 hours ( $p < 0.05$ ).

**Table 2.** Comparison of consumption of specific caffeinated beverages and time spent for specific screen media according to sleep duration

Variables	Sleep duration, hr/day			
	≤ 6.0 (n = 36)	6.1–7.0 (n = 110)	7.1–8.0 (n = 77)	> 8.0 (n = 26)
Consumption of specific caffeinated beverages, cup/day				
Coffee	0.7 ± 0.5*	0.4 ± 0.3 <sup>†</sup>	0.3 ± 0.4 <sup>†</sup>	0.2 ± 0.3 <sup>†</sup>
Tea	0.3 ± 0.6	0.3 ± 0.6	0.1 ± 0.4	0.5 ± 0.7
Soft drink	0.4 ± 0.4	0.4 ± 0.3	0.4 ± 0.3	0.4 ± 0.3
Energy drink	0.3 ± 0.4	0.2 ± 0.3	0.2 ± 0.3	0.2 ± 0.3
Chocolate/cocoa drink	0.1 ± 0.3 <sup>†</sup>	0.2 ± 0.5*	0.2 ± 0.6*	0.5 ± 0.9*
Time spent for specific screen media, hr/day				
TV	0.5 ± 0.7	0.7 ± 0.7	0.8 ± 0.8	0.8 ± 0.8
DVD movies	0.4 ± 0.4	0.3 ± 0.5	0.4 ± 0.6	0.4 ± 0.6
Computer	1.4 ± 0.8	1.3 ± 0.7	1.4 ± 0.7	1.1 ± 0.8
Mobile phone	1.6 ± 0.8	1.5 ± 0.6	1.5 ± 0.7	1.8 ± 0.7
Screen games	0.5 ± 0.7	0.4 ± 0.7	0.5 ± 0.7	0.5 ± 0.7
Total screen time spent, hr/day	4.4 ± 1.6	4.2 ± 2.0	4.6 ± 1.8	4.6 ± 2.2

\*,<sup>†</sup>Different marks indicate a statistical difference at  $p < 0.05$  in the post-hoc test using Scheffé's method after taking into account age, smoking experience, alcohol drinking experience, regular physical activity, weight loss attempts, and experience of working for making money.

**Table 3.** Comparison of consumption of specific caffeinated beverages and time spent for specific screen media according to the ESS scores

Variables	ESS scores		
	≤ 6 (n = 157)	7–8 (n = 44)	≥ 9 (n = 48)
Consumption of specific caffeinated beverages, cup/day			
Coffee	0.4 ± 0.4	0.4 ± 0.4	0.3 ± 0.3
Tea	0.3 ± 0.6	0.2 ± 0.5	0.3 ± 0.5
Soft drink	0.4 ± 0.3 <sup>†</sup>	0.5 ± 0.4*	0.4 ± 0.3 <sup>†</sup>
Energy drink	0.3 ± 0.3	0.2 ± 0.3	0.2 ± 0.2
Chocolate/cocoa drink	0.2 ± 0.5 <sup>†</sup>	0.1 ± 0.4 <sup>†</sup>	0.5 ± 0.8*
Time spent for specific screen media, hr/day			
TV	0.7 ± 0.8* <sup>†</sup>	0.5 ± 0.5 <sup>†</sup>	1.0 ± 0.9*
DVD movies	0.4 ± 0.6	0.4 ± 0.5	0.3 ± 0.5
Computer	1.3 ± 0.7	1.4 ± 0.6	1.4 ± 0.8
Mobile phone	1.5 ± 0.7 <sup>†</sup>	1.4 ± 0.7 <sup>†</sup>	1.8 ± 0.7*
Screen games	0.5 ± 0.7	0.3 ± 0.5	0.5 ± 0.7
Total screen time spent, hr/day	4.3 ± 2.0 <sup>†</sup>	3.9 ± 1.2 <sup>†</sup>	5.1 ± 1.9*

\*,<sup>†</sup>Different marks indicate a statistical difference at  $p < 0.05$  in the post-hoc test using Scheffé's method after taking into account age, smoking experience, alcohol drinking experience, regular physical activity, weight loss attempts, and experience of working for making money. ESS, Epworth Sleepiness Scale.

## DISCUSSION

In a cross-sectional study including 249 Korean male high school students, we examined that students with EDS had longer screen time, in particular longer time spent for a TV and a mobile phone, than those without EDS, which was defined using the ESS questionnaire. In addition, students with EDS or sleep duration longer than 8 hours consumed greater consumption of chocolate/cocoa drinks than those without EDS or those with shorter sleep duration, respectively. These findings suggest that screen time is associated with EDS and that consumption of certain types of caffeinated beverages is associated with EDS and sleep duration.

Sleep is necessary to maintain biological homeostasis and provide recovery process to restore energy balance in the body. Furthermore, sleep is essential for adolescents' growth and development because large amount of growth hormone and luteinizing hormone stimulating secretion of sex steroids are released during sleep. Thus, insufficient sleep in adolescents is likely to disturb normal physical and psychological development [8]. Accumulating

data show that both short and long sleep duration is detrimental to health [9]. Although biological mechanisms underlying the effects of long sleep are not clearly understood, long sleep may reflect poor sleep quality. Improper sleep quantity and quality results in EDS, which is chronic and persistent sleepiness throughout the day and even impairs one's daily functioning [1]. In fact, previous data demonstrated that EDS reduced academic performance in adolescents [2]. However, data on factors affecting EDS, besides insufficient sleep, in adolescents are still limited. Recently, working for making money [10], screen media exposure [11], mobile phone use [3,4], smoking and alcohol drinking [12], and substance use [13] may influence EDS in adolescents. However, no data on such factors related to EDS have not yet been reported for Korean adolescents, whose environmental factors may be different from those for adolescents in previous studies [3,4,10-13].

The present study observed that most of the study participants were exposed to caffeinated beverage consumption and screen media, but not exposed to smoking, alcohol drinking, or working for making money. Even if they cannot be representative for Korean male adolescents because they were high school students living in Seoul, adolescent students living in small cities or rural areas are likely to have similar extents of such environmental factors. In this study, short sleep was associated with coffee consumption, which is a predominant source of caffeine [14], but was not associated with screen time. Unexpectedly, students with longer sleep had longer screen time although these data were not statistically significant. In addition, they consumed greater amount of chocolate/cocoa drinks than those with shorter sleep duration. Furthermore, there were nonlinear threshold associations for ESS scores; students with EDS, which is defined as ESS scores  $\geq 9$ , showed longer screen time and consumed greater amount of chocolate/cocoa drinks than those without EDS. We cannot identify its causal associations underlying these findings at this point, but postulate that students exposed to longer time of screen media are likely to have low quality of sleep (rather than having low quantity of sleep), feel sleepy throughout the day, and drink a sweet caffeinated beverage to recover from drowsiness in the school.

Caffeine contents of major caffeinated beverages and products are 40–259 mg for coffees, 30–80 mg for teas, 36–71 mg for soft drinks, 12–25 mg for chocolate/cocoa products, and 42–141 mg for energy drinks [14]. To the best of our knowledge, there is only one study, which showed that substance use including caffeinated beverage consumption and tobacco use is associated with sleepiness scale scores in Italian adolescents [13]. Data for the association between the consumption of specific caffeinated beverages and EDS in adolescents are still limited. In this study, because chocolate/cocoa products seemed to be more available in a school store, students with EDS had significantly higher consumption of these products, although these products do not contain caffeine as much as other caffeinated products.

Previous 2 studies reported data on the association between screen time and sleepiness in Chinese and Japanese adolescents [3,4], but data are limited for adolescents with other ethnicities. Some mechanisms underlying the association of screen media with sleep quantity and quality have been suggested; adolescents with more time spent for screen media have less time for sleep; the content of screen media may cause psychological and physical arousal leading to low quality of sleep; light from screen media may cause disturbed circadian rhythm, which is associated with EDS [15].

It seems to be worthy that the present study provided novel data for Korean adolescents on the associations of caffeinated beverage consumption and screen time with EDS and sleep

duration. The study limitations including a small sample size, cross-sectional design, and limited generalizability need to be considered when our findings are interpreted. Finally, based on our findings, we suggest that adolescents reduce screen time and caffeinated beverage consumption for proper sleep quantity and quality.

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