



Association between Smartphone Addiction Risk, Sleep Quality, and Sleep Duration among Korean School-age Children: A Population-based Panel Study

Minah Park a,b, Sung Hoon Jeong a,b, Kyungduk Huhb,c, Yu Shin Park a,b, Eun-Cheol Park b,c, Suk-Yong Jang b,d *

^aDepartment of Public Health, Graduate School, Yonsei University
^bInstitute of Health Services Research, Yonsei University
^cDepartment of Preventive Medicine, Yonsei University College of Medicine
^dDepartment of Healthcare Management, Graduate School of Public Health, Yonsei University

INTRODUCTION

- Smartphones are becoming increasingly vital to daily life, as they provide access to a wide range of mobile applications used for communication, education, and entertainment.
- According to the Media Panel Survey, the smartphone ownership rate of elementary school students has been continuously increasing, with a rate of approximately 50% in 2015 soaring to 81.2% in 2019. In addition, Korean middle and high school students' smartphone ownership rate exceeds 95% according to a recent study.
- Good sleep quality and sufficient sleep duration is a necessity for school-age children. Lack of adequate sleep can lead to long-term sleep deprivation. In general, the quality of one’s sleep can have a direct effect on health and functioning,
- The scientific community is yet to reach a consensus on the definition of smartphone dependence. However, it is generally understood as excessive use of smartphones resulting in disruptions in daily functioning, and can be associated with physical and psychological problems.
- Thus, the aim of the present study was to examine the association between smartphone addiction, sleep quality, and sleep duration among Korean school children.

MATERIALS AND METHODS

- Data source:** Data from Korean Children & Youth Panel Survey from 2018–2019 were used.
- Study population:** Data were gathered from 4,287 individuals.
- Dependent variables:** The dependent variables were sleep quality and sleep duration. To assess sleep quality, the KCYPS inquired, “Normally, do you sleep well?” with four response options: “very well,” “well,” “poorly,” and “very poorly.” A response of “poorly” or “very poorly” was interpreted as poor sleep quality. Sleep duration was assessed based on the average bedtime and wake-up time of participants on weekdays. Sufficient sleep duration was defined as 9 to 10 hours for fourth grade students and 7.5 to 9 hours for seventh grade students in this study
- Interesting variables:** The variable of interest was smartphone addiction. The KCYPS used the Smartphone Addiction Proneness Scale developed by Kim et al. The scale consists of 15 items, and participants responded to each item on a four-point Likert-type scale (scored 1–4). Three items were reverse scored. The total score could range from 15 to 60. Scores were used to categorize addiction into three levels according to the standards of the Internet Addiction Prevention Center: low-risk (≤41), potential-risk (42–44), and high-risk (≥45). Participants were also asked, “How long do you spend using a smartphone for fun?” with response options of less than 1 hour, 1–2 hours, 2–3 hours, 3–4 hours, and more than 4 hours.
- Covariates:** The covariates included gender, age group, household income, region, time spent talking with parents, school grades, school satisfaction, perceived health status, exercise, computer use time, television viewing, and private education.
- Statistical analysis:** The Chi-square test was used to investigate the association between the covariates, sleep duration, and sleep quality. To determine the association between smartphone addiction and sleep duration, we conducted repeated measures analyses for multinomial responses using generalized estimating equations. For sleep quality, we conducted repeated measures analyses for binomial responses using generalized estimating equations. The results are reported using odds ratios (ORs) and confidence intervals (CIs). Differences were considered statistically significant at p-values of < .05. The data were analyzed for the entire sample and then stratified by gender using SAS 9.4 (SAS Institute Inc., Cary, NC, USA).

RESULTS

Table 1. Baseline(2018) Characteristics of Study Subject

	Sleep Quality				P Value	Sleep Duration						P Value
	Good		Poor			Short		Appropriate		Long		
	N	%	N	%		N	%	N	%	N	%	
Total(n=4287)	3,779	(88.2)	508	(11.8)		1,131	(26.4)	2,816	(65.7)	340	(7.9)	
Smartphone Addiction Risk												
					<.0001							<.0001
Low Risk	3,595	(88.8)	455	(11.2)		1,036	(25.6)	2,693	(66.5)	321	(7.9)	
Potential Risk	89	(76.7)	27	(23.3)		43	(37.1)	67	(57.8)	6	(5.2)	
High Risk	95	(78.5)	26	(21.5)		52	(43.0)	56	(46.3)	13	(10.7)	

- Table 1 presents the general characteristics of the participants at baseline. Among the 4,287 participants, 11.8% (n = 508) reported poor sleep quality, 26.4% (n = 1,131) reported short sleep duration, and 7.9% (n = 340) reported long sleep duration.

Table 2. Associations between Sleep Quality, Sleep Duration and Subject Demographics

Variables	Sleep Quality		Sleep Duration			
	Bad		Short		Long	
	OR	95% CI	OR	95% CI	OR	95% CI
Smartphone Addiction Risk						
Low Risk	1.00		1.00		1.00	
Potential Risk	1.27	(0.88 - 1.82)	1.44	(1.09 - 1.90)	1.31	(0.81 - 2.10)
High Risk	1.59	(1.06 - 2.38)	2.25	(1.66 - 3.05)	1.11	(0.66 - 1.88)

- Table 2 shows the results of the generalized estimating equation (GEE) for the association between smartphone addiction risk and sleep quality, and between smartphone addiction risk and sleep duration. Regarding sleep quality, children in the high-risk group showed an increased likelihood of poor sleep quality compared to those in the low-risk group (odds ratio (OR) = 1.59, confidence interval (CI) [1.06-2.38]). Regarding sleep duration, children in the potential-risk and high-risk groups showed an increased likelihood of short sleep duration compared to those in the low-risk group (potential high-risk group: OR = 1.44, CI [1.09-1.90]; high-risk group: OR = 2.25, CI [1.66-3.05]).

RESULTS

Table 3. Subgroup analysis stratified by various characteristics

Variables	Bad Sleep Quality					Short Sleep Duration*					Long Sleep Duration*				
	Smartphone Addiction Risk					Smartphone Addiction Risk					Smartphone Addiction Risk				
	Low Risk		Potential Risk		High Risk	Low Risk		Potential Risk		High Risk	Low Risk		Potential Risk		High Risk
	OR	95% CI	OR	95% CI		OR	95% CI	OR	95% CI		OR	95% CI	OR	95% CI	
Sex															
Male	1.00	1.45 (0.71 - 2.98)	2.43 (0.98 - 6.02)			1.00	1.19 (0.77 - 1.84)	1.93 (1.21 - 3.09)			1.00	1.57 (0.89 - 2.80)	1.40 (0.74 - 2.66)		
Female	1.00	2.52 (1.17 - 5.42)	3.44 (1.47 - 8.07)			1.00	1.61 (1.11 - 2.34)	2.51 (1.65 - 3.81)			1.00	0.89 (0.37 - 2.14)	0.78 (0.30 - 2.04)		
Age group															
4th Grade	1.00	1.02 (0.55 - 1.89)	1.24 (0.62 - 2.47)			1.00	1.27 (0.83 - 1.94)	2.07 (1.25 - 3.42)			1.00	0.58 (0.19 - 1.73)	1.18 (0.47 - 2.92)		
7th Grade	1.00	1.37 (0.87 - 2.14)	1.75 (1.07 - 2.88)			1.00	1.55 (1.08 - 2.22)	2.39 (1.64 - 3.48)			1.00	1.67 (0.97 - 2.87)	1.07 (0.56 - 2.05)		
Talking with Parent															
≤2	1.00	1.22 (0.81 - 1.85)	1.71 (1.10 - 2.66)			1.00	1.50 (1.10 - 2.05)	2.23 (1.64 - 3.03)			1.00	1.32 (0.76 - 2.27)	1.24 (0.72 - 2.13)		
>2	1.00	1.24 (0.52 - 2.97)	0.87 (0.16 - 4.65)			1.00	1.27 (0.70 - 2.29)	2.49 (0.97 - 6.42)			1.00	1.17 (0.45 - 3.03)	0.45 (0.06 - 3.57)		
School Grade															
Good	1.00	1.27 (0.75 - 2.16)	1.11 (0.44 - 2.82)			1.00	1.45 (0.93 - 2.25)	2.78 (1.65 - 4.68)			1.00	1.78 (0.85 - 3.73)	1.15 (0.44 - 3.02)		
Average	1.00	1.29 (0.71 - 2.33)	1.67 (0.85 - 3.27)			1.00	1.58 (1.01 - 2.48)	1.81 (1.13 - 2.89)			1.00	0.92 (0.40 - 2.11)	1.42 (0.64 - 3.12)		
Bad	1.00	1.72 (0.74 - 4.00)	2.49 (1.18 - 5.25)			1.00	1.23 (0.67 - 2.23)	2.53 (1.41 - 4.55)			1.00	1.21 (0.51 - 2.90)	0.96 (0.34 - 2.73)		
School Satisfaction															
Good	1.00	0.46 (0.11 - 1.91)	0.71 (0.12 - 4.26)			1.00	1.21 (0.84 - 1.75)	2.48 (1.71 - 3.60)			1.00	1.35 (0.71 - 2.55)	1.74 (0.95 - 3.21)		
Average	1.00	1.32 (0.75 - 2.33)	1.12 (0.54 - 2.34)			1.00	2.06 (1.32 - 3.22)	1.90 (1.04 - 3.49)			1.00	1.47 (0.66 - 3.29)	0.46 (0.13 - 1.58)		
Bad	1.00	1.63 (1.06 - 2.49)	2.33 (1.47 - 3.71)			1.00	1.10 (0.36 - 3.34)	3.05 (1.16 - 7.97)			1.00	0.53 (0.10 - 2.87)	0.80 (0.17 - 3.77)		
Private Education															
≤2	1.00	1.49 (0.91 - 2.46)	2.00 (1.18 - 3.39)			1.00	1.62 (1.10 - 2.39)	2.21 (1.46 - 3.34)			1.00	1.48 (0.81 - 2.67)	1.27 (0.70 - 2.30)		
>2	1.00	1.17 (0.73 - 1.87)	1.35 (0.74 - 2.48)			1.00	1.27 (0.86 - 1.87)	2.40 (1.56 - 3.69)			1.00	1.07 (0.48 - 2.37)	0.61 (0.18 - 2.12)		

- Table 3 provides the GEE results for the subgroup analysis stratified by the independent variables. Among seventh graders, participants who were in the potential high-risk or high-risk group were 1.75 times more likely to have poor sleep quality and 2.39 times more likely to have short sleep duration. Additionally, there was an increased likelihood of poor sleep quality (OR = 2.33, CI [1.47-3.71) and short sleep duration (OR = 3.05, CI [1.16-7.97]) among participants in the high-risk group who were dissatisfied with school life.

Table 4. Smartphone Use Time and Sleep Quality and Sleep Duration

Variables	Bad Sleep Quality		Short Sleep Duration*		Long Sleep Duration*	
	OR	95% CI	OR	95% CI	OR	95% CI
Smartphone Use Time						
Under 1 hour	1.00		1.00		1.00	
1.0-1.9 hour	0.98	(0.81 - 1.19)	1.30	(1.13 - 1.49)	0.73	(0.59 - 0.91)
2.0-2.9 hour	1.11	(0.89 - 1.38)	1.83	(1.57 - 2.14)	0.72	(0.56 - 0.94)
3.0-3.9 hour	1.36	(1.00 - 1.83)	2.94	(2.38 - 3.63)	0.55	(0.35 - 0.86)
more than 4.0 hour	1.64	(1.24 - 2.16)	2.95	(2.37 - 3.66)	0.38	(0.24 - 0.60)

* The results of multinomial logistic regression using the GEE

- Table 4 shows the results of the generalized estimating equation (GEE) for the association between smartphone use time, sleep quality, and sleep duration. The results showed a dose-response relationship.
- When daily usage was over 2 hours, there were increased odds of having poor sleep quality, and when daily usage was over 1 hour there were increased odds of having a short sleep duration.

DISCUSSION

- In this study, we examined the associations between smartphone addiction, sleep quality, and duration in Korean school children. The results revealed that children in the high-risk group showed an increased likelihood of poor sleep quality compared to those in the low-risk group, and children in the potential high-risk and high-risk groups had an increased likelihood of short sleep duration compared to those in the low-risk group.
- Our results also show that children who spent less time talking with their parents in the high-risk smartphone addiction group were more likely to have poor sleep quality and short sleep duration. In addition, children who spent less time engaging in private education were more likely to have poor sleep quality and short sleep duration. A possible reason for this is the major role played by parents and teachers in resolving issues related to addiction. Parental involvement is key in managing children’s behavior and preventing the problematic use of smartphones. Children who receive low level of parental care may have difficulty establishing good relationships with others, and thus rely more heavily on smartphone usage.
- In our study, female participants in the potential-risk or high-risk group showed a higher likelihood of poor sleep quality and short sleep duration than male participants. There are several possible explanations for this finding. According to a previous study, smartphone usage differs by gender; boys are more likely to use their smartphone for gaming purposes, whereas girls are more likely to use it for communicating through social media or texting
- There are several limitations to this study. First, smartphone addiction was assessed using questions developed in Korea. Therefore, generalizability of these findings to other countries and populations is limited. Second, sleep duration was self-reported, and sleep quality was assessed through a single question. Standardized questionnaires such as the Pittsburgh Sleep Quality Indexor a more precise set of questions should be considered in future research. Third, some important factors that affect sleep, such as anxiety, alcohol use, and smoking, were not considered. However, despite these limitations, these findings suggest that smartphone addiction may contribute to poor sleep quality and quantity in adolescents, and this should be regarded as a public health threat to children and adolescents.

CONCLUSION

- Children who are at high risk for smartphone addiction are likely to have poor sleep quality and short sleep duration.
- Therefore, appropriate interventions and steady monitoring are required to protect children from smartphone addiction and improve their sleep quality and sleep duration.