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The moderated mediating effect of parental smartphone addiction in the relationship between smartphone addiction, sleep duration, and depression among adolescents

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Purpose: This study aimed to examine whether sleep duration mediated the relationship between adolescent smartphone addiction and depression. Moreover, we investigated whether the mediating effects of sleep duration were moderated by parental smartphone addiction.
Methods: Wave 4(2021) data collected in 2021 from the Korean Children and Youth Panel Survey (KCYPS) 2018 was used. The data collected from 4,392 matched pairs of parents and their children was analyzed, using the SPSS PROCESS macro.
Results: Sleep duration partially mediated the relationship between adolescent smartphone addiction and depression. Also, parental smartphone addiction moderated the indirect effect of this mediation model.
Conclusion: This suggests that it is necessary to include content on the use of smartphones by adolescents as well as their parents when designing education and intervention programs to prevent depression in adolescents.

Keywords: Adolescent; Depression; Parents; Smartphone; Sleep Duration

Introduction

Worldwide, one out of seven adolescents aged 10 to 19 is reported to experience mental health problems, and depression is reported as one of the major causes of diseases and disabilities in this age group [1]. According to the results of the Korea Youth Risk Behavior Survey, the prevalence of depression among Korean adolescents aged 12 to 18 increased from 25.2% in 2020 to 28.7% in 2022 [2]. Depression is the most representative factor accounting for youth suicide [3], and suicide has been the leading cause of deaths among Korean adolescents since 2011 [4]. These data show that it is more urgently needed than ever to strengthen interventions and response measures for the psychological and emotional crises of youth. Depression in adolescents is highly likely to be comorbid with other mental health problems such as anxiety and substance abuse [5], and it is also associated with health risk behaviors and difficulty in academic performance or forming social relationships [6,7]. Depression in adolescence is reported to increase the risk for depression or suicide in adulthood, and it can also cause more severe depression, such as prolonged depressive episodes or the increased recurrence of depression [8,9].

Recently, as the use of smart devices has become widespread as a result of the development of digital technologies, our society has been undergoing innovative changes in the overall aspects of individuals' life. The use of digital services is being expanded in various areas ranging from daily activities, such as communication, leisure, shopping, and finance, to the solution of social problems related to COVID-19. However, despite various advantages of the digital era, excessive use of smart devices and dependence on the devices have detrimental effects in physical, psychological, relational, and behavioral aspects especially on ado-

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lescents who lack self-regulation, so smartphone dependence especially among adolescents has emerged as a social problem [10]. 98% of middle and high school students in Korea are reported to have smartphones [11]. In addition, it has been found that the proportion of the risk group for smartphone overdependence is higher in adolescents (40.1%) than any other age group, and the proportion of the risk group has been increasing every year [12]. Smartphone addiction is expressed in various terms, such as smartphone overdependence and excessive smartphone use, in previous studies, and these terms are currently used without any clear distinction between them, but they all imply that people spend too much time on smartphones to such a degree that they have difficulty doing daily activities [13]. As the digitalization of learning has been accelerated since the COVID-19 pandemic period, the use of smartphones has become part of everyday life, and adolescents themselves regard using the smartphone as their main leisure activity [12]. Considering these facts, it is very important to explore measures to prevent smartphone addiction. A longitudinal study of American adolescents reported that excessive smartphone use was associated with a higher level of depression even after one year of follow-up, even after adjusting for baseline depression levels [14]. In addition, smartphone addiction has been found to be a risk factor for depression [15,16], so there is an urgent need for active discussions to improve smartphone use behavior in adolescents.

Since adolescence is a stage during which significant physical, neurobiological, and psychosocial development occurs, sleep is important for adolescents. However, adolescence is also a period during which individuals are vulnerable to sleep problems. Physiological causes such as the delayed secretion of sleep-inducing hormones affect the phase of the circadian rhythm and delay bedtime. In addition, going to bed late due to an increased student workload and the social pressure for going to school early inevitably lead to a further decrease in sleep duration [17]. In adolescents, sleep deprivation has harmful effects on both physical and mental health, causing physical health problems such as cardiometabolic diseases and mental health problems such as mood disorders. Moreover, a lack of sleep is also linked to poor academic performance, health risk behaviors such as drug use, and the occurrence of safety accidents due to carelessness [18]. In particular, previous studies on smartphone addiction in adolescents paid attention to the association between smartphone addiction and sleep disturbance. It has been found that adolescents who own smartphones have shorter sleep durations and more sleep problems than those who do not use the smartphone [14]. In addition, a systematic literature review study [19] found that smartphone addiction is a factor contributing to sleep deprivation in adolescents.

Sleep duration has been shown to have a clear correlation with depression [18,20]. It has been reported that 69.1% of middle school students and 95.1% of high school students in Korea have sleep durations shorter than 8 hours, which is the minimum sleep duration recommended by the National Sleep Foundation [20,21], and these findings indicate that adolescents have a serious level of sleep deprivation. Although previous studies empirically demonstrated that lack of sleep is a risk factor for depression [18,20], the majority of adolescents in Korea do not get enough sleep. Although this inadequate sleep duration is partially due to a high proportion of time spent on academic duties such as homework and attending private educational institutes, a prior study found that the use of Internet sites such as watching videos online was the most common reason among middle school students and the third most common reason among high school students [21]. Sufficient sleep is important for adolescents because it helps to maintain an optimal emotional state and improve the emotional regulation ability [22]. As described above, sleep deprivation can cause very serious problems to the healthy development and mental health of adolescents, so it is important to identify risk factors that can affect sleep deprivation and find measures to prevent the problem.

Meanwhile, there is a need to examine the moderating effect of parental smartphone addiction on the effect of adolescent smartphone addiction on depression. As smartphone addiction increases problems such as the decrease of sleep duration and depression [15,16,19], research has been conducted to investigate home environment variables that affect smartphone addiction. As a result, the impact of parental smartphone addiction has been suggested in relation to explaining adolescent smartphone addiction [23-25]. Currently, in Korea, smartphone addiction among adolescents is considered a problem that needs to be addressed, and since parents' direct guidance on their children's smartphone use is the mainly used method to control adolescent smartphone addiction [12], research on the effectiveness of parental interventions is essentially needed. As Bandura's social learning theory emphasized the importance of observation and imitation [26], children learn the ways of living through their parents' daily lives [27]. In particular, as adolescents become more assertive and spend increasingly more time out of their parents' sight [14], the way parents behave in everyday life may have a greater effect than one-sided parental control.

Therefore, in consideration of the above findings of previous studies, this study aimed to verify whether parental smartphone

addiction moderates the mediating effect of sleep duration on the relationship between adolescent smartphone addiction and depression. The specific research questions of this study are expressed as follows: First, does smartphone addiction affect depression in adolescents?; second, does sleep duration have a mediating effect on the relationship between smartphone addiction and depression in adolescents?; third, does parental smartphone addiction moderate the mediating effect of sleep duration on the relationship between adolescent smartphone addiction and depression in adolescents?

Methods

This study is a secondary data analysis research using data of the fourth wave (2021) of the Korean Children and Youth Panel Survey (KCYPS) 2018, and this data was provided by the Korea Youth and Children Data Archive (https://www.nypi.re.kr/archive/mps). The conceptual research model that the present study attempted to verify is presented in Figure 1. Research hypotheses based on each research question are as follows:

H1. Smartphone addiction will have a positive impact on depression in adolescents.

H2. Sleep duration will have a mediating effect on the relationship between smartphone addiction and depression in adolescents.

H3. Parental smartphone addiction will moderate the mediating effect of sleep duration on the relationship between smartphone addiction and depression in adolescents.

Participants

This study used the fourth wave data of KCYPS 2018 conducted by the National Youth Policy Institute. KCYPS 2018 is a longitudinal study conducted with 2 cohorts extracted from fourth-grade elementary school students and first-year middle school students nationwide by a multi-stage stratified cluster sampling method. The original panel consisted of a total of 5,197 students, including 2,607 students in the fourth-grade elementary school student cohort and 2,590 students in the first-year middle school student cohort. This study was conducted with data from 2,275 first-year middle school students and 2,265 first-year high school students, who were the valid panel of the fourth wave (2021) of KCYPS 2018. Among the students, adolescents who were using the smartphone, whose parents were also using the smartphone, and who did not have missing values in key variables were included in the study. As a result, 4,392 students, including 2,194 first-year middle school students and 2,198 first-year high school students, and 4,392 parents of the students were included in the final analysis.

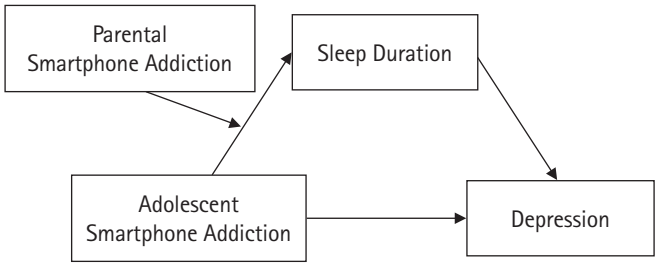

Figure 1. Conceptual model of this study.

Measures

1) Independent variable & moderator variable: Smartphone addiction

Smartphone addiction was analyzed using adolescents' and parents' responses for the self-report smartphone addiction proneness scale developed by Kim et al. (2012), which was included in KCYPS 2018. This scale contains a total of 15 items, and each item is assessed on a 4-point Likert scale ranging from 1 point (= 'Not at all') to 4 points (= 'Very much so'). Among the 15 items, the following three items were reverse-coded: Smartphone use does not interfere with my current work (studying)'; 'I do not feel anxious when I do not have the smartphone'; 'I do not spend a lot of time using the smartphone.' Since these three questions were reverse-coded, higher scores indicated higher levels of smartphone addiction. In this study, the value of Cronbach's α was .86 for adolescents and .84 for parents.

2) Dependent variable: depression

Depression was assessed using 10 questions from the 13 questions of the depression scale of the Korean version of Mini-Mental State Examination developed by Kim et al. (1984), which was included in KCYPS 2018. Each item was assessed on a 4-point Likert scale from 1 point (= 'Not at all') to 4 points (= 'Very much so'), and higher scores indicate higher levels of depression. The value of Cronbach's α was .90 in this study.

3) Mediating variable: Sleep duration

Sleep duration was measured using the question about the average bedtime and the average wake-up time during a week during the past semester (the first semester of 2021) from KCYPS 2018 data. In KCYPS 2018 data, both the bedtime and wake-up time were described in hour and minute, so sleep duration was calculated in the unit of hours to use the data for analysis.

4) Control variables

Based on a previous study on factors associated with depression [16], control variables in this study included gender (male/ female), parents' education level (middle school or lower/high school/college or higher), and average monthly household income (1 to 12 points). More specifically, the average monthly household income was measured on a 12-point scale by dividing income in units of 1 million won as follows: 'No income (1 point)'; 'Less than 1 million won (2 points)'; 'From 1 million to less than 2 million won (3 points)'; 'From 9 million won to less than 10 million won (11 points)'; 'More than 10 million won (12 points).'

Data analysis

In this study, data analysis was conducted using SPSS ver. 29.0 (IBM Institute, NY, USA), and $p < .05$ was considered statistically significant. First, to examine the characteristics of all the variables, descriptive statistical analysis was performed. Second, to verify research questions 1 and 2, the simple mediation effect was analyzed using PROCESS Macro Version 4.2 (Model 4). Third, to verify research question 3, the conditional process of whether the indirect effect is modulated by another variable was analyzed. In other words, the moderated mediation effect was analyzed using PROCESS Macro Version 4.2 (Model 7). The statistical significance of indirect effects of the mediation model and the conditional model was tested by calculating the 95% confidence interval by a bootstrapping method (number of samples: 5,000).

Ethical considerations

This study was conducted after receiving an exemption determination from the Public Institutional Review Board designated by the Ministry of Health and Welfare (IRB No. P01-202404-01-002).

Results

Characteristics of participants and major variables

Regarding the gender of adolescents, 2,281 people (51.9%) were male, and 2,111 people (48.1%) were female. For the education level of parents, college or higher accounted for the largest proportion (3,243 people, 73.8%). The average monthly household income was 7.07 points (±2.09) on a scale of 1 to 12 points. For the level of smartphone addiction, the mean score of adolescents was 32.00 points (±6.91), which was slightly higher than the mean score of parents (29.06 points (±6.04)). Adolescent smartphone addiction was negatively correlated with sleep duration ($r = -.03$, $p = .025$), but it showed a positive correlation with depression ($r = .35$, $p < .001$) and parental smartphone addiction ($r = .24$, $p < .001$). Sleep duration was negatively correlated with depression ($r = -.11$, $p < .001$), but it had a positive correlation with parental smartphone addiction ($r = .04$, $p = .004$), Depression was positively correlated with parental smartphone addiction ($r = .17$, $p < .001$) (Table 1).

Mediating effect of sleep duration on the relationship between smartphone addiction and depression in adolescents

The analysis results of a simple mediation model to verify Hy-

Table 1. Characteristics of the Sample (N=4,392)

Variable		Mean±SD	Range	Skew/Kurt	n(%)	1	2	3	4
						r (*p*)	r (*p*)	r (*p*)	r (*p*)
Sex	Male				2,281 (51.9)				
	Female				2,111 (48.1)				
Parental education	≤ Middle school				51 (1.2)				
	High school				1,098 (25.0)				
	≥ College				3,243 (73.8)				
Monthly household income		7.07 (2.09)	1~12	0.42/0.13					
1. Adolescent smartphone addiction		32.00 (6.91)	15~60	-0.03/-0.08		1			
2. Sleep duration (hours/day)		7.55 (1.22)	2.83~11.83	-0.33/0.24		-.03 (.025)	1		
3. Depression		17.52 (5.47)	10~40	0.52/-0.07		.35 (<.001)	-.11 (<.001)	1	
4. Parental smartphone addiction		29.06 (6.04)	15~60	-0.01/-0.11		.24 (<.001)	.04 (.004)	.17 (<.001)	1

Skew=skewness; Kurt=kurtosis.

potheses 1 and 2 are given in Table 2. In Step 1, adolescent smartphone addiction, the independent variable, had a significant positive effect on depression (B = 0.26, p < .001). In Step 2, adolescent smartphone addiction, the independent variable, had a significant negative effect on sleep duration, the mediating variable (B = -0.009, p < .001). In Step 3, when the mediating variable was additionally entered, adolescent smartphone addiction had a significant positive effect on depression (B = 0.25, p < .001), and sleep duration, the mediating variable, had a significant negative impact on depression (B = -0.46, p < .001). In other words, sleep duration was found to have a partial mediation effect on the relationship between adolescent smartphone addiction and depression.

The indirect effect of adolescent smartphone addiction on depression through sleep duration (B = 0.004, Boot 95% CI [0.001, 0.007]) was found to be statistically significant because the lower and upper bounds of the 95% confidence interval did not include 0.

Mediation effect of sleep duration moderated by parental smartphone addiction

The analysis results of the moderated mediation effect to test Hypothesis 3 is shown in Table 3. The interaction term of adolescent smartphone addiction and parental smartphone addiction was found to have a significant effect on sleep duration (B = 0.001, p < .001). This means that parental smartphone addiction moderated the relationship between smartphone addiction and sleep duration in adolescents. In other words, a lower level of adolescent smartphone addiction was associated with a longer sleep duration, and when the level of parental smartphone addiction was lower, the increase of sleep duration according to adolescent smartphone addiction was more pronounced (Figure 2). Additionally, it was also evident that sleep duration had a significant impact on depression (B = -0.42, p < .001).

The results of the analysis to test the significance of the conditional indirect effect described above are shown in Table 4. The moderated mediation index (B = -0.0006, Boot 95% CI [-0.001, -0.0002]), which is a quantified value for the impact of parental smartphone addiction as the moderator variable in the relationship between adolescent smartphone addiction, sleep duration, and depression, was statistically significant. More specifically, with respect to the conditional indirect effect according to the level of parental smartphone addiction (-1SD, M, +1SD), the conditional indirect effect was significant when the level of parental smartphone addiction was -1SD(B = 0.007, Boot 95% CI [0.003, 0.011]) or the average (B = 0.003, Boot 95% CI [0.001, 0.006]), but it was not significant when the level of parental smartphone addiction was +1SD (B = -0.0003, Boot 95% CI

Table 2. The Mediating Effect of Sleep Duration (N=4,392)

Step	Variable		B	SE	t (p)
1	Adolescent smartphone addiction	→ Depression	0.26	0.01	22.42 (< .001)
2	Adolescent smartphone addiction	→ Sleep duration	-0.009	0.003	-3.24 (< .001)
3	Adolescent smartphone addiction	→ Depression	0.25	0.01	22.17 (< .001)
	Sleep duration		-0.46	0.06	-7.25 (< .001)

Indirect effect	B	Boot SE	95% CI	
			Boot LLCI	Boot ULCI
Adolescent smartphone addiction → Sleep duration → Depression	0.004	0.001	0.001	0.007

B=coefficient; SE=standard error; CI=confidence interval; LLCI=lower level confidence interval; ULCI=upper level confidence interval; Adjusted for related variables.; Present up to three decimal places due to statistical numerical characteristics.

Table 3. The moderated mediation effect of sleep duration by parental smartphone addiction (N=4,392)

Variable	Dependent variable: Sleep duration				
	B	SE	t(p)	R^2	F(p)
Adolescent smartphone addiction (A)	-0.05	0.01	-3.99(< .001)		
Parental smartphone addiction (B)	-0.03	0.01	-2.46(.014)	0.01	8.97(< .001)
A * B	0.001	0.0004	3.38(< .001)		
Variable	Dependent variable: Depression				
	B	SE	t(p)	R^2	F(p)
Adolescent smartphone addiction	0.28	0.01	24.79(< .001)	0.14	144.25(< .001)
Sleep duration	-0.42	0.06	-6.63(< .001)		

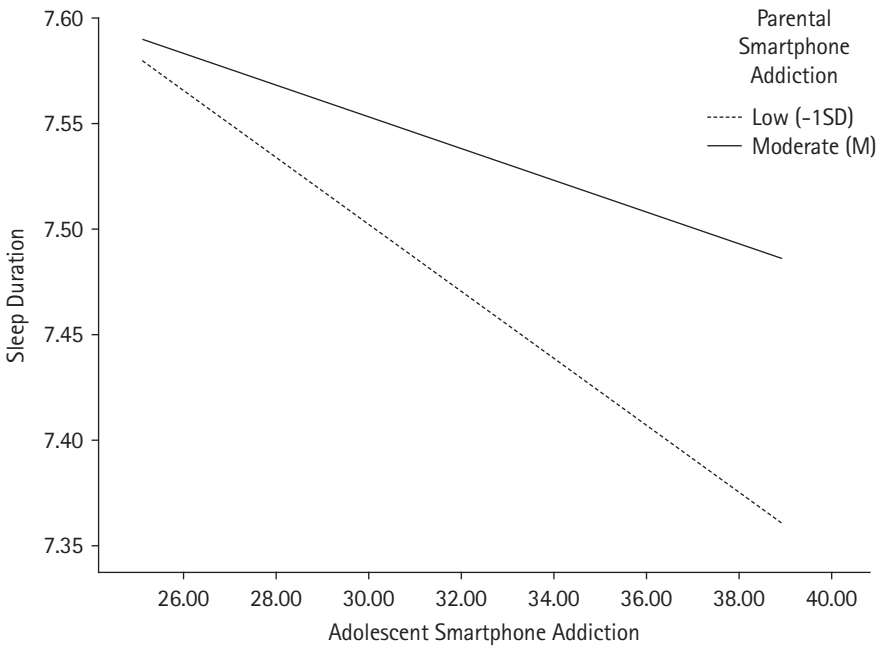

Figure 2. The moderating effect of parental smartphone addiction. SD=standard deviation; M=mean.

Table 4. Conditional Indirect Effects

Index of moderated mediation	B	Boot SE	95% CI	
			Boot LLCI	Boot ULCI
	-0.0006	0.0002	-0.001	-0.0002
Parental smartphone addiction level	B	Boot SE	95% CI	
			Boot LLCI	Boot ULCI
-1SD	0.007	0.002	0.003	0.011
M	0.003	0.001	0.001	0.006
+1SD	-0.0003	0.002	-0.004	0.003

LLCI=lower level confidence interval; ULCI=upper level confidence interval; Present up to four decimal places due to statistical numerical characteristics.

[-0.004, 0.003]). In other words, it was found that the indirect effect of smartphone addiction on depression through sleep duration in adolescents was moderated by parental smartphone addiction, and that the indirect effect was increased as the level of parental smartphone addiction was decreased except when the level of parental smartphone addiction was high.

Discussion

The main discussions of the results of this study are as follows. First, it was found that smartphone addiction had a positive effect on depression in adolescents, and these results were consistent with previous studies [15,16]. Kraut et al. [28] introduced the internet paradox model, and showed that the excessive use of the Internet is linked to a higher level of depression. Recently, the main device used to access the Internet is the smartphone [12], and the time spent on digital technologies by adolescents results in the cost of time for cognitive and social activities in real life that are beneficial for mental health [28]. Regarding the negative effects of smartphone addiction, it has also been found that smartphone addiction not only reduces the connectivity of brain regions that control emotions, decision-making, and impulses, but also increases the release of neurotransmitters such as gamma-aminobutyric acid (GABA), which cause people to experience attention distraction and loss of control [14]. In addition, it has been reported that attention deficit may have a mediating ef-

fect on the relationship between smartphone addiction and depression [16], and that lack of self-control may act as a moderator variable that moderates the relationship between smartphone addiction and depression [15]. According to a prior study, the neurological immaturity of adolescents makes them depend more on immediate rewards from smartphone use than on natural delayed rewards through interacting with friends or family or engaging in hobbies [14]. As a result, this tendency of adolescents may have negative impacts on interpersonal relationships, such as serious conflicts or quarrels between friends or family members, which may lead to getting disconnected from friends or the family [10]. Thus, as individuals become more immersed in relationships in virtual reality, they become more isolated from the real world, which may lead to the occurrence or worsening of depression [14]. According to a prior study of smartphone addiction in Korean adolescents, as the level of smartphone addiction was increased, the experience of face-to-face meetings was decreased as a result of using the smartphone as the main tool of communication, and the experience of actual face-to-face meetings was decreased to a greater degree among adolescents than any other age group [12], suggesting that depression is highly likely to develop or worsen among adolescents. Worldwide, mental health problems in adolescents are reported to account for 13% of disease burden, and, more seriously, negative effects of such problems can be extended to adulthood if appropriate interventions fail to prevent or improve them [1]. These findings suggest the urgency of early responses for the prevention of smartphone addiction, which is a risk factor for mental health problems.

Second, it was found that smartphone addiction reduces sleep duration, and thereby ultimately increases the level of depression in adolescents. These results are consistent with prior studies that reported the partial mediation effect of sleep duration on the relationship between the usage time of electronic devices such as smartphones and depression [29,30]. In this connection, several explanations on causal mechanisms regarding the relationship between smartphone addiction and sleep duration have been presented. First, blue light emitted from the smartphone display has been found to inhibit the production of melatonin, a sleep-inducing hormone in our body, thereby delaying sleep onset and disrupting sleep patterns [14]. Next, smartphone addiction has been shown to have a positive relationship with depression through bedtime delay as a mediator variable [15]. The increased time and frequency of smartphone use, one of the symptoms of smartphone addiction [14], lead to delayed bedtime and thus may make it difficult to secure adequate sleep duration. Meanwhile, sleep deprivation causes people to have trouble controlling emotions [22], and thereby can increase the risk for depression [18,20]. According to a survey of smartphone overdependence in Korea [12], the experience rate of insomnia and chronic fatigue due to the use of smartphones before sleep was 35.4% in adolescents, which was higher than in any other age group. In addition, although the rate of perception of excessive smartphone use was highest in adolescents (58.4%), the rate of perception that it is difficult to control smartphone use according to one's own will was also highest among adolescents. The above findings suggest that it is most important to strengthen adolescents' ability to control their smartphone use according to the value and purpose of smartphone use. In particular, as part of an effort to reduce adolescents' smartphone use before sleep, an educational intervention is required to help adolescents themselves to make decisions on the time and location of smartphone use and find and practice their own control methods.

Third, it was shown that the mediating effect of sleep duration on the relationship between smartphone addiction and depression in adolescents was increased as the level of parental smartphone addiction was decreased. In other words, this study verified the moderation effect of parental smartphone use as a protective factor for adolescent mental health. In other words, as the level of adolescent smartphone addiction decreased, sleep duration was increased in adolescents, so the decrease of adolescent smartphone addiction can ultimately prevent adolescent depression, and this positive effect was more pronounced as the level of parental smartphone addiction was lower. In Korea, the proportion of the risk group for smartphone overdependence is highest in adolescents among all age groups, and the rate of experience of control failure, which is one of the factors associated with smartphone overdependence, is also reported to be highest in adolescents. Control failure refers to the state in which a person fails at every attempt to reduce time spent on the smartphone, and experiences difficulty in controlling smartphone usage time or maintaining an appropriate amount of time spent on the smartphone [12]. With respect to the reason why adolescents are vulnerable in the control of smartphone use, adolescents tend to prefer activities providing strong excitement and rewards, and these developmental characteristics of adolescence are well matched with the characteristics of the smartphone, such as immediacy, portability, and versatility. In addition, since adolescents use the smartphone mainly for entertainment and interaction with peers, their smartphone use is very likely to lead to the excessive use of the device in relation to the motivation of media selection. Moreover, due to the characteristics of brain development during adolescence, adolescents are likely to show amygda-

la-centered responses, and thus may have difficulty in the control of their thoughts and behaviors [31]. In view of these facts, parents' role in the prevention of smartphone addiction among adolescents takes on great importance. This is due to the fact that as suggested by social learning theory [26], parents are people who spend most time with adolescents, and they are authority figures who can become role models for smartphone use as they are the objects of observation and imitation for their children. Although parents' guidance activities regarding their children's smartphone use are mostly focused on the restriction of smartphone apps or time spent on the smartphone per day, the proportion of the risk group for smartphone overdependence among Korean adolescents still remains high [12], and this fact indicates that parents cannot always control their children's smartphone use and there are clear limitations to simply banning and restricting adolescents' smartphone use. Therefore, to prevent adolescent smartphone addiction, which negatively affects mental health problems such as sleep and depression, it is necessary to examine parents' habitual smartphone use behavior as well, since it can be an environmental risk factor for smartphone addiction in adolescents. This study of Korean adolescents showed that parents should show exemplary behavior in terms of the appropriate use of the smartphone rather than just requiring their children to use the smartphone appropriately, and in this respect, it can be said that this study expanded the results of previous studies that revealed the association between adolescent smartphone dependence and parental smartphone dependence.

Since this study analyzed the relationship of major variables using cross-sectional data, it is suggested that follow-up research should be conducted to clarify causal relationships using longitudinal data. In addition, caution is needed in generalizing the results to all adolescents because this study used only data from first-year middle school students and first-year high school students included in a secondary data.

Conclusions

This study was conducted to understand depression in terms of its relationship with adolescent smartphone addiction, sleep duration, and parental smartphone addiction. To this end, this study verified the hypothesis that sleep duration will have a mediating effect on the relationship between adolescent smartphone addiction and depression, and also tested the hypothesis that parental smartphone addiction will have a moderated mediating effect. The results of this study suggest that when educational and interventional programs for the prevention of adolescent depression are designed, it is necessary to include content about parental smartphone use along with content about adolescents' smartphone use. The inclusion of educational content on parental smartphone use is required because parents' smartphone habits are highly likely to act as reference points for children's smartphone use behaviors, and will eventually have a significant impact on mental health in adolescents.

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Conflict of interest

The author declared no conflict of interest.

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None.

Authors' contributions

Eunha Jeong contributed to conceptualization, data curation, formal analysis, methodology, project administration, visualization, writing - original draft, review & editing, investigation, resources, software, supervision, and validation.

Data availability

Please contact the corresponding author for data availability.

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References

1. World Health Organization(WHO). Mental health of adolescents [Internet]. Geneva: World Health Organization. 2021 [cited 2024 Feb 1]. Available from: https://www.who.int/news-room/fact-sheets/detail/adolescent-mental-health
2. Ministry of Education; Korea Disease Control and Prevention Agency. The 18th Korea Youth Risk Behavior Survey, 2022 [Internet]. Cheongju: Korea Disease Control and Prevention Agency. 2023 [cited 2024 Feb 1]. Available from: https://www.kdca.go.kr/yhs/yhshmpg/result/yhsresult/statsBookList.do

3. Carballo JJ, Llorente C, Kehrmann L, Flamarique I, Zuddas A, Purper-Ouakil D, et al. Psychosocial risk factors for suicidality in children and adolescents. European Child & Adolescent Psychiatry. 2020;29(6):759–776. https://doi.org/10.1007/s00787-018-01270-9
4. Ministry of Gender Equality & Family. 2022 Youth Statistics [Internet]. Seoul: Ministry of Gender Equality & Family. 2022 [cited 2024 Feb 1]. Available from: https://www.mogef.go.kr/nw/rpd/nw_rpd_s001d.do?mid=news405
5. Lewinsohn PM, Rohde P, Seeley JR. Major depressive disorder in older adolescents: Prevalence, risk factors, and clinical implications. Clinical Psychology Review. 1998;18(7):765–794. https://doi.org/10.1016/S0272-7358(98)00010-5
6. Brooks TL, Harris SK, Thrall JS, Woods ER. Association of adolescent risk behaviors with mental health symptoms in high school students. Journal of Adolescent Health. 2002;31(3):240–246. https://doi.org/10.1016/S1054-139X(02)00385-3
7. Keenan-Miller DMA, Hammen CLPD, Brennan PAPD. Health outcomes related to early adolescent depression. Journal of Adolescent Health. 2007;41(3):256–262. https://doi.org/10.1016/j.jadohealth.2007.03.015
8. Clayborne ZM, Varin M, Colman I. Systematic review and meta-analysis: Adolescent depression and long-term psychosocial outcomes. Journal of the American Academy of Child and Adolescent Psychiatry. 2019;58(1):72–79. https://doi.org/10.1016/j.jaac.2018.07.896
9. Johnson D, Dupuis G, Piche J, Clayborne Z, Colman I. Adult mental health outcomes of adolescent depression: A systematic review. Depression and anxiety. 2018;35(8):700–716. https://doi.org/10.1002/da.22777
10. Ministry of Science and ICT. The 5th Basic Plan for Prevention and Resolution of the smartphone/Internet Overdependence (2022~2024) [Internet]. Sejong: Ministry of Science and ICT. 2022 [cited 2024 Feb 1]. Available from: https://www.msit.go.kr/publicinfo/view.do?mId=&publictSeqNo=195&publictListSeqNo=4
11. Bae SR, Lee CH. Youth Media Usage & Policy Response Study II: Teenagers. Basic Analysis Report. Sejong: National Youth Policy Institute; 2021 December. Report No.: 21-R17-2.
12. Ministry of Science and ICT; National Information Society Agency. The Smartphone overdependence Survey, 2023 [Internet]. Daegu: National Information Society Agency. 2024 [cited 2024 Mar 29]. Available from: https://www.nia.or.kr/site/nia_kor/ex/bbs/View.do;jsessionid=59CF94D00B49C8120A1190332EB11316.96d8b21e765106361634?cbIdx=65914&bcIdx=26508&parentSeq=26508
13. Shin SC, Song HW. The moderating effect of self-esteem on the relationship between the smartphone overuse, aggression and impulsiveness of elementary school students. The Korean Journal of Child Education. 2019;28(4):231–245. http://dx.doi.org/10.17643/KJCE.2019.28.4.13
14. Ting CH, Chen YY. Smartphone addiction. In: Essau CA, Delfabbro PH, editors. Adolescent addiction: Epidemiology, assessment, and treatment. 2nd ed. London, England: Academic Press; c2020. p. 215–240.
15. Geng Y, Gu J, Wang J, Zhang R. Smartphone addiction and depression, anxiety: The role of bedtime procrastination and self-control. Journal of Affective Disorders. 2021;293:415–421. https://doi.org/10.1016/j.jad.2021.06.062
16. Park Y, Lee S. Gender differences in smartphone addiction and depression among Korean adolescents: Focusing on the internal mechanisms of attention deficit and self-control. Computers in Human Behavior. 2022;136:107400. https://doi.org/10.1016/j.chb.2022.107400
17. Carskadon MA, Acebo C, Jenni OG. Regulation of adolescent sleep: Implications for behavior. Annals of the New York Academy of Sciences. 2014;1021(1):276–291. https://doi.org/10.1196/annals.1308.032
18. Owens JA, Weiss MR. Insufficient sleep in adolescents: causes and consequences. Minerva Pediatrica. 2017;69(4):326–336. https://doi.org/10.23736/S0026-4946.17.04914-3
19. Mac Carthaigh S, Griffin C, Perry J. The relationship between sleep and problematic smartphone use among adolescents: A systematic review. Developmental Review. 2020;55:100897. https://doi.org/10.1016/j.dr.2020.100897
20. National Sleep Foundation. Sleep in America® Poll 2024 [Internet]. Washington, DC: National Sleep Foundation. 2024 [cited 2024 Mar 29]. Available from: https://www.thensf.org/wp-content/uploads/2024/03/NSF-Sleep-in-America-2024-Report_final.pdf
21. Yoo MS, Lee GS. A Study on the Implementation of the international convention on the rights of children and youth - human rights status of children and youth in Korea. Basic Research Report. Sejong: National Youth Policy Institute; 023 December. Report No.: 23-General01-01.
22. Fuligni AJ, Bai S, Krull JL, Gonzales NA. Individual differences in optimum sleep for daily mood during adolescence. Journal of Clinical Child & Adolescent Psychology. 2019;48(3):469–479. https://doi.org/10.1080/15374416.2017.1357126
23. Bae EJ, Nam SH. How mothers' problematic smartphone use affects adolescents' problematic smartphone use: mediating

roles of time mothers spend with adolescents and adolescents' self-esteem. Psychology Research and Behavior Management. 2023;16:885–892. https://doi.org/10.2147/PRBM.S401515
24. Kim SH, Jeong KH, Ryu JH. The effects of parental smartphone addiction sub-factors on children's smartphone addiction. The Journal of Humanities and Social Sciences. 2022;30(1):31–49. https://doi.org/10.22924/jhss.30.1.202202.002
25. Ha MS. Relationship between mother's smartphone addiction and adolescents' smartphone addiction: verification of multiple mediating effects of negative parenting attitude, social withdrawal, and depression. Asian Journal of Education. 2020;21(4):1001–1035. https://doi.org/10.15753/aje.2020.12.21.4.1001
26. Bandura A. Social learning theory. Englewood Cliffs, N.J: Prentice Hall; 1977. 149 p.
27. Terras MM, Ramsay J. Family digital literacy practices and children's mobile phone use. Frontiers in psychology. 2016;7:213065. https://doi.org/10.3389/fpsyg.2016.01957
28. Kraut R, Patterson M, Lundmark V, Kiesler S, Mukophadhyay T, Scherlis W. Internet paradox: A social technology that reduces social involvement and psychological well-being? American Psychologist. 1998;53(9):1017–1031. https://doi.org/10.1037/0003-066X.53.9.1017
29. Liu J, Liu CX, Wu T, Liu BP, Jia CX, Liu X. Prolonged mobile phone use is associated with depressive symptoms in Chinese adolescents. Journal of Affective Disorders. 2019;259:128–134. https://doi.org/10.1016/j.jad.2019.08.017
30. Wang W, Du X, Guo Y, Li W, Zhang S, Zhang W, et al. Associations among screen time, sleep duration and depressive symptoms among Chinese adolescents. Journal of Affective Disorders. 2021;284:69–74. https://doi.org/10.1016/j.jad.2021.01.082
31. Ministry of Science and ICT, National Information Society Agency. Guidelines Manual to prevent smartphones overdependence for child and adolescent guardians [Internet]. Daegu: National Information Society Agency. 2019 [cited 2024 Apr 19]. Available from: https://www.iapc.or.kr/mediaView.do?idx=28&article_id=ICCART_0000000113014&type=A1