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Original Article

Association between Smartphone Overdependence, Health Behaviors, and Oral Symptom Experience among Adolescents

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ABSTRACT

Objectives: This study aimed to examine the associations between smartphone overdependence, health behaviors, and oral symptom experience among adolescents. **Methods:** Data from the 19th (2023) Korea Youth Risk Behavior Survey were analyzed for 48,990 participants. Complex sample analysis and multiple logistic regression were conducted to examine the associations between smartphone overdependence, health behaviors, and oral symptom experience. **Results:** Smartphone overdependence was significantly associated with an increased risk of tooth fracture, chewing discomfort, tooth pain, and gingival bleeding. Lower toothbrushing frequency was associated with increased risks of chewing discomfort, tooth pain, and gingival bleeding. Adolescents who slept less than 7 hours showed higher risks of chewing discomfort and tooth pain, while an inverse association was observed for gingival bleeding. **Conclusions:** Smartphone overdependence and health behaviors were associated with oral symptom experience among adolescents. To improve oral health, an integrated approach is needed that includes appropriate smartphone use, sufficient sleep duration, and improved personal hygiene behaviors.

Keywords: Adolescents, Health behaviors, Oral symptom experience, Smartphone overdependence, Toothbrushing

1. Introduction

In modern society, smartphones have become essential devices that extend beyond simple communication tools, serving important roles in information acquisition, academic activities, and the formation of social relationships. According to the 2023 Korea Media Panel Survey, the smartphone ownership rate among Korean adolescents aged 10–19 years was 95.7%, and 95.5% of adolescents perceived smartphones as an essential medium, which was the highest among all age groups [1]. As smartphones are increasingly recognized as indispensable media, the inability to control their use may lead to excessive dependence, which can negatively affect the physical and mental health of adolescents. This phenomenon is particularly prominent during adolescence, a critical period for the formation of healthy lifestyles and health management habits [2].

Lifestyle and health management habits formed during adolescence are important factors that influence overall health and quality of life in adulthood. During this critical developmental period, smartphones have become deeply embedded in adolescents' daily lives and provide various positive functions. However, excessive smartphone use may lead to reduced self-control and irregular lifestyle behaviors, which can negatively affect overall health [2].

In particular, excessive smartphone use may lead to smartphone overdependence, increasing the risk of addiction and causing anxiety when the device is unavailable [3]. The National Information Society Agency of Korea defines smartphone overdependency as a state characterized by decreased self-regulation and the occurrence of problematic consequences[4]. If this condition worsens,

it may lead to tolerance and withdrawal symptoms that interfere with daily life. Therefore, continuous monitoring and evaluation of adolescents have been emphasized [5].

Adolescence is a period of rapid physical growth and development within the life course, and it represents a critical stage during which lifelong health behaviors are established [6]. However, the rapid proliferation of smartphones and the increasing level of dependence have been associated with weakened self-regulation among adolescents, leading to imbalances in overall health behaviors [7].

Handwashing is the most basic component of health behavior and is the simplest and most effective preventive measure to protect the body from infections in daily life [3].

In particular, handwashing and toothbrushing are essential health behaviors for preventing infectious diseases and dental conditions. When these practices are insufficient, the risk of transmitting pathogenic microorganisms increases, which may also elevate the risk of various oral diseases, including dental caries and periodontal disease [8,9].

Adolescents with a high level of smartphone overdependence are more likely to experience fatigue, sleep deprivation, impaired physical development, emotional instability, reduced attention, and feelings of lethargy, which can lead to negative consequences for their daily activities and healthy living [10]. Such fatigue, lethargy, and irregular daily rhythms may lead adolescents to neglect oral health behaviors in daily life, particularly oral hygiene practices such as regular toothbrushing, thereby increasing the risk of deteriorating oral health.

Above all, adolescence is a transitional period characterized by physical, psychological, and social changes, and the establishment of proper oral health behaviors during this stage is critically important, as it can influence lifelong oral health [11]. For this reason, inadequate hygiene habits and unhealthy behaviors during this period may threaten oral health throughout life. Oral diseases cause not only pain and discomfort but also negatively affect eating habits, learning activities, and psychological well-being, thereby ultimately lowering quality of life during adolescence [12].

Previous studies have reported associations between smartphone overdependence and various factors, including dietary habits, oral health behaviors, general health behaviors, sleep duration, mental health, personal hygiene practices, risk of allergic diseases. However, comprehensive research integrating smartphone overdependence, personal hygiene practices, and oral health among adolescents remains scarce [3,13–15]. In particular, most prior studies have been limited to exploring fragmented correlations between individual variables, failing to elucidate the complex pathways through which smartphone overdependence influences oral health. In contrast, research investigating the complex pathways through which smartphone overdependence, as a modern lifestyle factor, influences oral health via interactions and sequential changes in health behaviors among adolescents remains insufficient.

Therefore, this study aimed to comprehensively analyze the relationships among smartphone overdependence, personal hygiene practices, and oral health from an integrated perspective, rather than examining these factors in isolation. There is a need to provide foundational evidence for establishing effective hygiene habits to promote oral health in adolescents and to intervene in risk factors that may persist into adulthood. Accordingly, using data from the 19th Korea Youth Risk Behavior Web-based Survey (2023), this study analyzed the associations between smartphone overdependence, daily health behaviors, and oral symptom experience. The findings of this study are expected to provide evidence to support the development of health policies and educational programs aimed at improving oral health among adolescents.

2. Methods

2.1. Analysis Target

This study used data from the 19th Korea Youth Risk Behavior Survey (KYRBS, 2023). The survey was conducted jointly by the Korea Disease Control and Prevention Agency and the Ministry of Education to assess health behaviors among Korean adolescents and to support the development and evaluation of health policies. The 2023 survey included the smartphone overdependence Prone- ness Scale (SAPS), which is the key variable of this study, allowing for a more precise analysis aligned with the study objectives. Therefore, considering data consistency and variable availability, the 2023 dataset was selected as the final dataset for analysis. The 19th KYRBS was conducted among middle and high school students from 800 sampled schools across 17 metropolitan cities and provinces nationwide. Approximately 60,000 students participated in a self-administered online survey designed to assess health behaviors such as smoking, alcohol consumption, and physical activity.

The sampling frame for the sample design was constructed using data on all middle and high schools nationwide as of April 2020. The process was conducted in three stages: stratification of the population, allocation of the sample, and sample extraction.

In the stratification stage, the population was divided into 117 strata using 39 regional groups and education

level (middle schools, general high schools, specialized high schools) as stratification variables to minimize sampling error.

In the sample allocation stage, the sample size was allocated to 400 middle schools and 400 high schools, and 5 middle schools and 5 high schools were first assigned to each of the 17 metropolitan cities and provinces. The final sample was then selected using a stratified cluster sampling method. In the 2023 survey, in-depth investigations were conducted on mental health, atopy/asthma, substance use, internet addiction (including an added item on smartphone overdependence), and health equity, and an additional handwashing item was included within the personal hygiene section.

In this study, data from the 2023 Korea Youth Risk Behavior Survey (KYRBS) conducted among 57,346 students from 800 middle and high schools were used. Among them, 48,990 participants who responded to all items related to smartphone overdependence, health behaviors, and oral symptom experience were included in the final analysis. This study was reviewed by the Institutional Review Board (IRB) of H University (IRB No. 1014585-202509-HR-002-01) and was approved for exemption from review because no personally identifiable information was collected or recorded.

2.2. Analysis variable

1) General Characteristics

In this study, general characteristics included gender, education level, household income, and household type. Gender was categorized as male or female, and education level was classified as middle school or high school. Economic status was reclassified into high, middle, and low. Household type was determined based on the question, "What is your current living arrangement?" respondents who reported living with their family were classified as "living with family," and all other responses were classified as "not living with family".

2) Health Behaviors

Health behaviors were assessed based on sleep duration, personal hygiene practices (handwashing), and toothbrushing frequency. Sleep duration was calculated based on reported bedtime and wake-up time over the past seven days. However, weekend data were excluded due to ambiguity in AM/PM responses, and only weekday sleep duration was used for analysis to ensure data accuracy. The categorization of sleep duration was based on the average sleep duration of Korean adolescents (7 hours and 18 minutes) reported by the National Youth Policy Institute. This is notably shorter than the OECD average of 8 hours and 22 minutes [16]. Reflecting the actual status of sleep deprivation among Korean adolescents, a cut-off point of 7 hours was established for this study. Accordingly, sleep duration was dichotomized into "short sleep" (< 7 hours) and "appropriate sleep" (≥7 hours).

Handwashing as a health behavior was assessed based on the question, "How often did you wash your hands with soap in the past 7 days?" The survey examined handwashing practices in specific situations, at school before meals and after using the restroom, and at home before meals, after using the restroom, and upon returning home after going out. Responses were presented as 'Always washed', 'Mostly washed', 'Sometimes washed', or 'Never washed'. During analysis, these were reclassified as 'Washed (Always/Mostly/Sometimes)' and 'Did not wash', categorized as Yes or No.

Toothbrushing frequency was surveyed based on the previous day (yesterday). The responses were categorized into three groups: once a day or less, twice a day, and three or more times a day.

3) Oral Symptom Experience

Four questions regarding oral symptom experience over the past 12 months were analyzed. The states analyzed were: teeth chipping or breaking (tooth fracture), pain in teeth when chewing or eating (chewing discomfort), throbbing or aching tooth pain (tooth pain), and sore gums or bleeding gums (gingival bleeding). These were categorized as present or absent.

4) Smartphone overdependence

Smartphone overdependence was assessed using the 10-item Smartphone Overdependence Scale developed by the National Information Society Agency (NIA), which has been adopted as a standardized measure in nationally approved surveys [4]. Each item was rated on a 4-point Likert scale ranging from 1 ("not at all") to 4 ("very much"), with a total possible score of 40.

According to the National Information Society Agency (NIA) guidelines, adolescents with scores of 23–30 are classified as the "potential risk group," and those with scores of 31 or higher as the "high-risk group," both of which indicate reduced self-regulation in smartphone use and the emergence of problematic outcomes in daily life[4].

For the purpose of statistical efficiency and to facilitate a clearer comparison between groups, this study adopted the analytical approach used in previous research. Based on the clinical cut-off point of 23 suggested by the NIA, participants were categorized into a normal group (< 23) and an overdependence group (≥23), combining the potential risk and high-risk groups for analysis [4,17].

2.3. Statistical Analysis

The Korea Youth Risk Behavior Survey employs a complex sampling design. Therefore, to obtain unbiased estimates, complex sample analyses were conducted by applying stratification variables, cluster variables, and sampling weights. Statistical analyses were performed using IBM SPSS Statistics (version 25.0; IBM Corp., Armonk, NY, USA).

To examine smartphone overdependence according to health behaviors and oral symptom experiences, and oral symptom experiences according to health behaviors and smartphone overdependence, complex sample cross-tabulation with the Rao-Scott χ^2 test was performed.

Furthermore, the effects of health behaviors and smartphone overdependence on oral symptom experiences were analyzed using multiple logistic regression for complex samples. The level of statistical significance was set at $\alpha = 0.05$.

3. Results

3.1. General Characteristics of Study Participants

The general characteristics of the study participants showed that males accounted for 51.1% and females for 48.9%, indicating a similar distribution. The majority of participants lived with their families 96.2%.

Regarding health behaviors, 89.4% of participants reported brushing their teeth three or more times per day, while 66.2% reported sleeping less than 7 hours. In terms of smartphone overdependence, 72.1% were classified as the overdependence group, whereas 27.9% were in the normal group. Oral symptom experience was reported in the following order: chewing discomfort 33.0%, toothache 22.5%, gingival bleeding 20.0%, and tooth fracture 10.4% <Table 1>.

Table 1. General Characteristics of Study Participants

n=48,990

Variables			n†	%‡
Gender		Male	24,594	51.1
		Female	24,396	48.9
Education level		Middle school	26,266	50.8
		High school	22,724	49.2
Economic status		High	5,718	12.1
		Medium	42,353	86.1
		Low	919	1.8
Living status		Living with family	46,810	96.2
		Not living with family	2,180	3.8
Health behaviors_ Handwashing				
School	before meals	No	9,425	19.9
		Yes	39,565	80.1
	after using the restroom	No	1,889	4.0
		Yes	47,101	96.0
Home	before meals	No	5,449	11.1
		Yes	43,541	88.9
	after using the restroom	No	2,021	4.1
		Yes	46,969	95.9
After going out		No	2,537	5.0
		Yes	46,453	95.0
Toothbrushing frequency (times/day)		1	570	1.1
		2	4,664	9.5
		3+	43,756	89.4
Sleep duration (hours sleep)		<7	31,615	66.2
		≥7	17,375	33.8
smartphone overdependence		overdependence	35,454	72.1
		normal	13,536	27.9
Oral Symptom Experience				
Tooth fractures		No	43,806	89.6
		Yes	5,184	10.4
Chewing discomfort		No	32,793	67.0
		Yes	16,197	33.0
Tooth pain		No	38,017	77.5
		Yes	10,973	22.5
Gingival bleeding		No	39,239	80.0
		Yes	9,751	20.0

† Unweighted number
‡ Weighted percent

3.2. Smartphone Overdependence according to Health Behaviors and Oral Symptom Experience

Differences in adolescents health behaviors and oral symptom experience according to smartphone overdependence were examined, and all variables showed significant differences between the normal and overdependence groups ($p < .001$).

Regarding health behaviors, the rate of handwashing before meals at school was 82.3% in the normal group and 74.4% in the overdependence group, while the rate at home was 90.3% and 85.1%, respectively. For toothbrushing frequency, the rate of brushing once per day was 1.6% in the overdependence group and 0.9% in the normal group, whereas the rate of brushing three or more times per day was 90.7% in the normal group and 86.0% in the overdependence group. The proportion of participants who slept less than 7 hours was 63.7% in the normal group and 72.6% in the overdependence group ($p < .001$).

In terms of oral symptom experience, the prevalence of chewing discomfort was 28.3% in the normal group and 45.0% in the overdependence group, while toothache was reported by 18.2% and 33.5%, respectively. Additionally, gingival bleeding was reported by 17.5% in the normal group and 26.4% in the overdependence group. The prevalence of tooth fracture was 9.9% in the normal group and 11.5% in the overdependence group ($p < .001$) <Table 2>.

3.3. Effects of Health Behaviors and Smartphone Overdependence on Oral Symptom Experiences

After adjusting for sex, educational level, household income, and living arrangement, a complex sample multiple logistic regression analysis was performed to examine the effects of health behaviors and smartphone overdependence on oral symptom experience.

Tooth fracture was significantly associated with handwashing practices and smartphone overdependence. Adolescents who did not wash their hands after using the school restroom had a higher likelihood of experiencing tooth fracture than those who did (OR = 1.255, 95% CI: 1.016–1.550). In contrast, those who did not wash their hands before

Table 2. Smartphone Dependence According to Health Behaviors and Oral Symptom Experience

Unit: n(%)‡

Variable			Normal	Overdence	F	*p*
Health behaviors_ Handwashing						
School	before meals	No	6,073(17.7)	3,352(25.6)	304.466	*<.001*
		Yes	29,381(82.3)	10,1841(74.4)		
	after using the restroom	No	1,215(3.5)	674(5.2)	61.447	*<.001*
		Yes	34,239(96.5)	3,433(94.8)		
Home	before meals	No	3,433(9.7)	2016(14.9)	242.811	*<.001*
		Yes	32,021(90.3)	11,520(85.1)		
	after using the restroom	No	1,242(3.5)	779(5.7)	99.262	*<.001*
		Yes	34,212(96.5)	12,757(94.3)		
After going outside		No	1600(4.4)	937(6.8)	116.359	*<.001*
		Yes	33,8542(95.6)	12,599(93.2)		
Toothbrushing frequency (times/day)		1	353(0.9)	217(1.6)	90.976	*<.001*
		2	2,996(8.4)	1,668(12.4)		
		3+	32,105(90.7)	11,651(86.0)		
Sleep duration (hours sleep)		<7	21,982(63.7)	9,633(72.6)	281.257	*<.001*
		≥7	13,472(36.3)	3,903(27.4)		
Oral Symptom Experience						
Tooth fractures		No	31.856(90.1)	11,9500(88.5)	21.925	*<.001*
		Yes	3,598(9.9)	1,586(11.5)		
Chewing discomfort		No	25,396(71.7)	7,397(55.0)	908.065	*<.001*
		Yes	10,058(28.3)	6,139(45.0)		
Tooth pain		No	29,012(81.8)	9,005(66.5)	1147.73	*<.001*
		Yes	6,442(18.2)	4,531(33.5)		
Gingival bleeding		No	29,292(82.5)	9,947(73.6)	458.83	*<.001*
		Yes	6,162(17.5)	3,589(26.4)		

‡Weighted count(weighted %)
F: Rao-Scott test

meals at home showed a lower likelihood (OR = 0.807, 95% CI: 0.738–0.887). In addition, the overdependence group had a higher likelihood of tooth fracture compared with the normal group (OR = 1.200, 95% CI: 1.121–1.289).

Chewing discomfort was significantly associated with handwashing practices, toothbrushing frequency, sleep duration, and smartphone overdependence. Adolescents who did not wash their hands before meals at school showed higher odds of oral symptoms (OR = 1.083, 95% CI: 1.026–1.143), as did those who did not wash their hands before meals at home (OR = 1.092, 95% CI: 1.063–1.186). Furthermore, compared with those who brushed their teeth three or more times per day, the odds were significantly higher for those who brushed once per day (OR = 1.422, 95% CI: 1.182–1.711) and those who brushed twice per day (OR = 1.261, 95% CI: 1.172–1.357). Adolescents who slept less than 7 hours per day had higher odds (OR = 1.182, 95% CI: 1.125–1.242), and the overdependence group showed higher odds compared with the normal group (OR = 1.965, 95% CI: 1.873–2.066).

Tooth pain was significantly associated with handwashing before meals at home, toothbrushing frequency, sleep duration, and smartphone overdependence. Adolescents who did not wash their hands before meals at home had higher odds (OR = 1.098, 95% CI: 1.001–1.204). Compared with those who brushed their teeth three or more times per day, the odds of oral symptoms were significantly higher for those who brushed once or less per day (OR = 1.514, 95% CI: 1.232–1.859). The odds were also increased for those who brushed twice per day (OR = 1.248, 95% CI: 1.157–1.345). Those who slept less than 7 hours per day had higher odds (OR = 1.279, 95% CI: 1.208–1.355), and the overdependence group had higher odds compared with the normal group (OR = 2.105, 95% CI: 2.004–2.212).

Gingival bleeding was significantly associated with toothbrushing frequency, sleep duration, and smartphone overdependence. Compared with brushing three or more times per day, the odds of oral symptoms were significantly higher for brushing once or less (OR = 1.398, 95% CI: 1.119–1.747) and twice per day (OR = 1.258, 95% CI: 1.161–1.363). Adolescents who slept less than 7 hours per day had lower odds (OR = 0.841, 95% CI: 0.794–0.891), while the overdependence group showed higher odds compared with the normal group (OR = 1.595, 95% CI: 1.511–1.681) <Table 3>.

Table 3. Effects of Health Behaviors and Smartphone Overdependence on Oral Symptom Experiences

Variables			Tooth fracture	Chewing discomfort	Tooth pain	Gingival bleeding
			OR†(95%CI)	OR†(95%CI)	OR†(95%CI)	OR†(95%CI)
Health behaviors_ Handwashing						
school	before meals	Yes (Ref.)				
		No	0.807 (0.735 – 0.887)***	1.083 (1.026–1.143)*	1.057 (0.991 – 1.127)	1.504 (0.9846–1.219)
	after using the restroom	Yes (Ref.)				
		No	0.938 (0.765–1.150)	0.914 (0.793–1.053)	1.044 (0.898–1.214)	1.0447 (0.889–1.227)
Home	before meals	Yes (Ref.)				
		No	0.983 (0.871 – 1.109)*	1.092 (1.063–1.186)*	1.098 (1.001–1.204)*	1.004 (0.918–1.098)
	after using the restroom	Yes (Ref.)				
		No	1.255 (1.016 – 1.550)*	1.081 (0.953–1.227)	1.040 (0.896–1.208)	1.103 (0.941–1.292)
After going outside		Yes (Ref.)				
		No	1.015 (0.851–1.210)	0.986 (0.888–1.095)	1.052 (0.926–1.194)	1.045 (0.925–1.180)
Toothbrushing frequency (times/day)		≥3 (Ref.)				
		1	1.281 (0.979–1.677)	1.422 (1.182–1.711)***	1.514 (1.232–1.859)***	1.398 (1.119–1.747)**
		2	1.704 (0.969-1.190)	1.261 (1.172–1.357)***	1.248 (1.157–1.345)***	1.258 (1.161–1.363)***
Sleep duration (hours sleep)		≥7 (Ref.)				
		<7	1.607 (0.992–1.147)	1.182 (0.125–1.242)***	1.279 (1.208–1.355)***	0.841 (0.794–0.891)***
smartphone overdependence		Normal (Ref.)				
		Overdependence	1.200 (1.121–1.289)***	1.965 (1.873–2.066)***	2.105 (2.004–2.212)***	1.595 (1.511–1.681)***

†CI, confidence interval; OR, adjusted odds ratio; OR, odds ratio.
Data analysis used multiple logistic regression : adjusted for sex, education level, ho usehold income, living arrangement
*p<0.05, **p<0.01, ***p<0.001

4. Discussion

This study examined the effects of smartphone overdependence and overall health behaviors, including handwashing, toothbrushing, and sleep habits, on oral symptom experience among Korean adolescents.

After adjusting for all sociodemographic factors and health behavior variables, the overdependence group showed a significantly higher risk of experiencing all oral symptoms compared with the normal group. These included tooth fracture, chewing discomfort, toothache, and gingival bleeding. In particular, the strongest association was observed for toothache (OR = 2.105, 95% CI: 2.004–2.212), suggesting that smartphone overdependence may serve as a key risk factor threatening adolescents' oral health.

These findings are consistent with previous studies reporting that excessive smartphone use is associated with deteriorated oral health status [13,18,19]. Moreover, the results suggest that smartphone overdependence not only increases usage time but also reduces adherence to basic personal hygiene behaviors [20,21]. Furthermore, when combined with insufficient sleep and irregular dietary habits, may contribute to the deterioration of the oral pathological environment.

Regarding sleep, adolescents who slept less than 7 hours per day showed higher odds of chewing discomfort and toothache, whereas lower odds were observed for gingival bleeding (OR = 0.841, 95% CI: 0.794–0.891). This contrasting finding may reflect the cross-sectional nature of the study, suggesting the possibility of reverse causality. Adolescents with existing oral symptoms may have responded differently due to prior treatment experiences or heightened symptom awareness.

In addition, sleep deprivation and smartphone overdependence may be associated with reduced cognitive function and health literacy, potentially leading to under-recognition or underreporting of early inflammatory symptoms such as gingival bleeding [22].

Nevertheless, sleep deprivation has been reported to promote inflammatory cytokine production and impair immune function, thereby contributing to periodontal inflammation [23,24]. These findings suggest that smartphone overdependence may influence adolescents oral health through sleep-related pathways [18,22]. Accordingly, sleep patterns may serve as an indicator of overall health behavior in adolescents, and further longitudinal studies are needed to clarify causal relationships.

Meanwhile, an inverse association was observed between handwashing before meals at school and tooth fracture (OR = 0.807, 95% CI: 0.735–0.887). This finding suggests that handwashing may function as a proxy variable reflecting overall health behavior rather than an independent risk factor. Personal hygiene behaviors tend to cluster with other health behaviors, and the observed direction of association may have been influenced by interactions with other variables with greater explanatory power [6,25].

In addition, increased smartphone use may lead to increased snacking behavior and late-night eating, which can elevate sugar intake and reduce water consumption, thereby increasing the risk of oral symptoms such as dental caries, toothache, and tooth fracture [7,26,27]. Previous studies have also reported that higher levels of smartphone overdependence are associated with lower toothbrushing frequency and a higher likelihood of not using oral hygiene products, supporting the notion that these behavioral changes create an environment vulnerable to oral diseases [3,10].

Furthermore, depression and anxiety associated with smartphone overdependence may affect the autonomic nervous system, increasing tension in the masseter muscle and leading to parafunctional habits such as sleep bruxism [23,28,29]. These habits can impose excessive mechanical loading on the teeth, weakening their structural integrity and contributing to tooth fracture and chewing discomfort [30].

Taken together, smartphone overdependence should be understood not merely as a behavioral issue but as a multifactorial factor that influences oral health through various pathways, including sleep, dietary habits, and psychological stress. Future longitudinal studies are needed to better understand causal relationships and the role of these mediating pathways.

Smartphone overdependence in adolescents can disrupt daily routines and negatively affect a healthy lifestyle [17]. In the present study, the overdependence group showed shorter sleep duration and lower rates of handwashing and toothbrushing compared with the normal group. This may be because adolescents tend to use smartphones more before bedtime to make up for limited leisure time. In addition, excessive nighttime exposure to smartphone screens may interfere with melatonin secretion, thereby reducing sleep quality and disrupting daily rhythms [6,31,32].

Disrupted daily rhythms may reduce the regularity of personal hygiene behaviors. Sleep deprivation and circadian misalignment can weaken self-control, leading to less frequent toothbrushing and handwashing, and ultimately poorer overall health management [33].

Furthermore, immersive activities such as video streaming, gaming, and social media use may promote prolonged smartphone use, resulting in decreased physical activity

and deterioration of health behaviors [34]. The concurrent decrease in toothbrushing and handwashing observed in this study suggests that personal hygiene behaviors may function as a behavioral cluster rather than as independent habits [6,25].

These findings suggest that smartphone overdependence is not merely a matter of time use but a multifactorial factor that disrupts adolescents' overall health management and daily routines, thereby increasing the risk of both oral and general health problems [21].

This study is meaningful in that it analyzed the associations between smartphone overdependence, health behaviors, and oral symptoms using a nationally representative sample. However, several limitations should be considered.

First, this study employed a cross-sectional design, which limits the ability to establish temporal relationships among variables and precludes direct causal inference. In particular, the inverse associations observed for some variables may reflect the possibility of reverse causality, and future longitudinal studies are needed to clarify causal relationships.

Second, the use of self-reported data may have introduced reporting bias, including recall bias and social desirability bias.

Third, some variables, such as sleep duration and oral hygiene behaviors, were simplified into binary or categorical forms, which may have limited the ability to capture their continuous or qualitative characteristics.

Despite these limitations, this study provides empirical evidence, based on large-scale national data, that smartphone overdependence is closely associated with adolescents' health behaviors and oral health. Future studies using more precise measurements and longitudinal designs are needed to further clarify these relationships.

5. Conclusions

This study examined the associations between health behaviors, smartphone overdependence, and the experience of oral symptoms among adolescents. The results are summarized as follows.

1. A total of 48,990 adolescents were included in the analysis. Among health behaviors, the prevalence of handwashing ranged from 80.1% to 96.0% depending on the item, and 89.4% of participants reported brushing their teeth three or more times per day. In addition, 66.2% of participants reported sleeping less than 7 hours per day, and 72.1% were classified as belonging to the smartphone overdependence group. Regarding oral symptoms experienced during the past 12 months, chewing discomfort 33.0% was the most frequently reported, followed by tooth pain 22.5%, gingival bleeding 20.0%, and tooth fracture 10.4%.
2. The association between smartphone overdependence and health behaviors as well as oral symptoms was examined using a complex sample chi-square analysis. Smartphone overdependence showed significant associations with health behaviors, including handwashing, toothbrushing, and sleep duration, as well as with oral symptoms such as tooth fracture, chewing discomfort, tooth pain, and gingival bleeding. These findings indicate that smartphone overdependence is closely related to healthy lifestyle habits and behaviors among adolescents.
3. Based on the results of complex sample multiple logistic regression analysis examining the associations between oral symptom experience and related factors, smartphone overdependence was identified as a significant risk factor for oral symptom experience. In addition, lower toothbrushing frequency was significantly associated with increased risks of chewing discomfort, tooth pain, and gingival bleeding. Adolescents who slept less than 7 hours showed significantly higher risks of chewing discomfort and tooth pain, while a lower risk was observed for These findings suggest that smartphone overdependence is not only directly associated with oral symptoms but may also indirectly influence oral health through lifestyle factors such as sleep deprivation and reduced personal hygiene practices.

In conclusion, smartphone overdependence among adolescents is associated with imbalanced lifestyle habits, including insufficient sleep and reduced personal hygiene practices, which increase the risk of oral symptoms such as tooth fracture, chewing discomfort, toothache, and gingival bleeding. To improve oral health, an integrated approach is needed that includes appropriate smartphone use, adequate sleep, and strengthened personal hygiene practices. Schools and families play a key role in supporting adolescents to develop these healthy habits.

Author Contribution

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Conflicts of Interest

The authors declare no conflict of interest.

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