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Depressive Symptoms, Emotional Aggression, School Adjustment, and Mobile Phone Dependency Among Adolescents with Allergic Diseases in South Korea

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ABSTRACT

Purpose: This study aimed to examine the effects of depression, aggression, and school adjustment on mobile phone dependency among South Korean adolescents, and to identify the differences in these paths among adolescents with or without allergic diseases.
Design and methods: The Korean Children and Youth Panel Survey, a nationwide multistage cluster sampling survey, was used for this cross-sectional study. Data were collected from 1937 first-year middle school students in South Korea, using self-reported questionnaires. Multiple-group structural equation modeling was used to test the differences of the critical ratio for the variables depressive symptom, emotional aggression, school adjustment, and mobile phone dependency between adolescents with allergic diseases and those without allergic disease.
Results: Depressive symptoms and emotional aggression were significantly higher in the allergic disease group. Significantly different effects were found on the path of depressive symptoms to school adjustment and depressive symptoms to mobile phone dependency.
Conclusions: Higher depressive symptoms in allergic disease adolescents had a greater negative effect on school adjustment and a more positive effect on mobile phone dependency. Healthcare professionals need to be concerned not only with the physical symptoms of adolescents with allergic diseases but also with psychological issues, such as depression.
Practice implications: Early assessments and interventions for depressive symptoms in adolescents with allergic diseases could help prevent over dependency on mobile phones, as well as maladjustment to school.

With the rapid development of technology and the spread of smartphones in recent years, the penetration rate of mobile phones in South Korea reached 94% in 2017, making South Korea the global leader in smart phone ownership (Sohn, 2018). The percentage of South Koreans who selected mobile phones as the most important essential medium in everyday life surged from 24.3% in 2012 to 56.4% in 2017 (Korea Communications Commission, 2017). According to a 2016 survey on youth media usage, adolescents used mobile phones mainly to access media such as messenger, social networking services (SNS), real-time Internet broadcasting, and video sites (Ministry of Gender Equality and Family, 2016). Middle school students' dependency on smart phones was the highest (34.3%), compared with elementary school students (22%), high school students (28.7%), and college students (23.8%), according to a survey on smart phone overdependence by the National Information Society Agency (2017). Overdependence or overuse of mobile phones can lead not only to physical problems such as eye ailments, muscular pain, migraine, and psychological problems such as withdrawal, sleep problems, anxiety and depression, but also to poor academic achievement and school maladjustment (De-Sola, Talledo, Rubio, & de Fonseca, 2017; Elhai, Dvorak, Levine, & Hall, 2017; Kang & Park, 2012; Lemola, Perkinson-Gloor, Brand, Dewald-Kaufmann, & Grob, 2015).

Since adolescents' overdependence on mobile phones has become a major social concern globally, a number of studies have been conducted to analyze the relationship between the psychological characteristics of adolescents and mobile phone dependency. Depression, which is a common emotional problem in adolescence, has been continuously reported as a risk factor for mobile phone dependency; adolescents with high depression depend on mobile phones to resolve internal conflicts and stresses and maintain social affiliation (Kang & Shin, 2014; Lee & Chung, 2018; Nho & Kim, 2016; Yen et al., 2009). Emotional aggressiveness is also a negative psychological factor affecting mobile phone dependency (Kang & Shin, 2014; Kim & Song, 2015; Lee & Chung, 2018;

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Nho & Kim, 2016; Ryu & Hong, 2014). Adolescents with emotional aggression, such as hostility or anger, are less likely to have social relationships, and more likely to engage in mobile phone use. Furthermore, emotional aggression that is not resolved in reality can be expressed in the virtual world (Ryu & Hong, 2014).

In addition, school maladjustment has been reported to have a significant correlation with higher levels of mobile phone dependency (Kang, Jang, & Kim, 2014; Lee & Kwon, 2014; Lee & Myung, 2007). One of the most important tasks of adolescence is to adapt to school life. School adjustment is an active process to balance the environment and the individual in the school environment through changes in the environment or oneself (Gwak, 2006). School adjustment is affected by psychological characteristics such as depression and emotional aggression (Fröjd et al., 2008; Kim & Song, 2015; Nho & Kim, 2016). Adolescents with depressive symptoms experience a low level of knowledge acquisition and difficulties in academic performance and relationships with teachers and friends (Kim & Chun, 2015). Emotional aggression is also an important factor influencing school adjustment (Graham, Bellmore, & Mize, 2006; Keum, Son, Chae, & Kang, 2013). Adolescents who exhibit high emotional aggression not only experience difficulty forming relationships with teachers and friends due to hostile interpersonal and coercive attitudes, but can also experience serious school maladjustment problems because of antisocial behavior, such as violence and suicide attempts (Kim & Chun, 2015).

Meanwhile, few studies have examined the impact of physical health on mobile phone dependency. Allergic diseases such as allergic rhinitis, atopic dermatitis, and asthma are among the most common chronic diseases in adolescents. According to the Korean Statistical Information Service, the prevalence of allergic diseases among adolescents in 2017 was as follows: allergic rhinitis (35.8%), atopic dermatitis (25.1%), and asthma (8.8%). These ailments have increased rapidly in South Korea and are now close to the rates of developed Western countries (Mallol et al., 2013).

Adolescents with allergic diseases are more likely to experience psychological and behavioral impairments such as depression, emotional aggression, and poor learning habits (Garg & Silverberg, 2014). The prevalence rate of depression among adolescents with asthma and atopic dermatitis is 17.2% and 13%, respectively, which is almost twice the figures for those without allergic diseases (Chun et al., 2015). Also, adolescents with allergic diseases experience emotional aggression such as irritability and acting-out behavior (Wamboldt, Schmitz, & Mrazek, 1998). Allergic diseases also lead to school maladjustment such as poor accomplishment and absenteeism, not only because of the allergic symptoms (e. g., skin etching, sneezing, dyspnea, fatigue, and sleep distraction) and drug complications (e. g., daytime sleepiness) but also because of the psychological problems (e. g., depression and emotional aggression). Moreover, adolescents with allergic diseases are more likely to be associated with a gaming addiction (Shiue, 2015) and longer internet use (Kim, 2012; Lee et al., 2015), which have common features with mobile phone overdependence. Disease characteristics of allergic diseases such as limitation in outdoor activities, as well as related psychological problems and maladjustment in school life, could affect the mobile phone dependency. However, few studies have investigated the impact of allergic diseases on mobile phone dependency.

According to the interaction of person-affect-cognition-execution (I-PACE) model, proposed by Brand, Young, Laier, Wolfling, and Potenza (2016), specific internet-use disorders are the result of interaction between predisposing factors such as biopsychology constitution, psychopathology, personality, and social cognition. These situational factors are perceived subjectively and could be factors influencing the use of specific internet applications/sites (Brand et al., 2016). Since mobile phone overdependence/overuse is a specific form of information technology addiction, we set up a structural model for mobile phone dependency based on the I-PACE model; allergic diseases as biopsychology constitution; depression as psychopathology; emotional aggression as personality; school adjustment as social cognition; mobile phone dependency as a specific internet-use disorder. Therefore, this study aimed (1) to examine the effects of depression, aggression, and school adjustment on mobile phone dependency among adolescents with or without allergic diseases, and (2) to identify the differences in these paths among adolescents with or without allergic diseases.

Methods

Data collection and management

The data for this cross-sectional study were derived from the Korean Children and Youth Panel Survey (KCYPS). The National Youth Policy Institute conducted KCYPS every year from 2010 to 2016, and provided seven years of prospective panel data on personal development and the environment of South Korean adolescents. The strength of KCYPS is that it provides geographically representative data, as the sampling procedure is conducted by the multistage cluster sampling method: 95 schools were chosen by probability proportional to size sampling from 27 areas, and 95 classes were extracted randomly from the 95 sample schools. We used the seventh year of the dataset, the latest, in which the participants were in the first year of middle school in 2016. We included 1937 sample respondents, excluding incomplete data ($n = 341$) and individuals who were not using a mobile phone ($n = 65$), and extracted data on demographics, self-reported questionnaires of depressive symptoms, emotional aggression, school adjustment, and mobile phone dependency. To classify the adolescents with or without allergic disease, self-reported questions ('Have you had the following health problems during the past year?') asked students about health problems they may have experienced, including asthma, allergic rhinitis, and atopic dermatitis. Adolescents who answered 'yes' to one or more of the questions related to these three conditions were defined as belonging to the group with allergic diseases.

Measurements

Adolescents completed the following self-reported measurements: depressive symptoms (the Korean version of Symptom Checklist), emotional aggression (Emotional or Behavioral Problem Scale), school adjustment (School Life Adjustment Scale), and mobile phone dependency (Lee's scale for mobile phone dependency). Each measurement used a 4-point Likert scale: 1 (strongly agree) to 4 (strongly disagree). However, in the present study, to make it easier for the readers to understand, the item scores were reversed as 1 (strongly disagree) to 4 (strongly agree).

Depressive symptoms were measured by the depressive symptom subscale of the Korean version of the Symptom Checklist (SCL-90) (Kim, Kim, & Won, 1984) widely used self-reported scales covering several psychopathological states. The measurement consisted of 10 items after excluding three items from the original Symptom Checklist, as used in the KCYPS. Higher scores indicate more depressive symptoms. The correlation between the depression subscale of SCL-90 and BDI-II was 0.89 (Steer, Ball, Ranieri, & Beck, 1997), and the Cronbach's alpha coefficients for these items were 0.899 in the study sample.

Emotional aggression was measured by six items of a scale developed by Cho and Lim (Cho & Lim, 2003), including items such as "I get into fights over small things". Higher scores indicate a higher level of aggression. The Cronbach's alpha coefficients for these items were 0.826 in this study's sample.

Mobile phone dependency was measured by a 7-item instrument established in Lee and colleagues' study (Lee et al., 2002), one of the most frequently used instruments among Korean children and adolescents. The items concern the degree of dependency on using a mobile phone, such as "I feel anxious without my mobile phone." Higher scores indicate a higher dependency on a mobile phone. The Cronbach's alpha coefficients were 0.896 in this study sample.

Table 1
Comparison of characteristics among adolescents with and without allergic diseases.

		Allergic diseases ($n = 826$)		No allergic disease ($n = 1111$)		χ^2 or t
Gender	Boys	448	(54.2)	544	(49.0)	5.16*
	Girls	378	(45.8)	567	(51.0)	
Allergic disease	Asthma	110	(13.3)			
	Allergic rhinitis	690	(83.6)			
	Atopic dermatitis	251	(30.4)			
Depressive symptoms		17.23	(5.61)	16.35	(5.42)	3.49**
Emotional aggression		11.23	(3.42)	10.87	(3.42)	2.32*
School adjustment		31.15	(4.68)	30.98	(4.50)	0.82
Learning activity		15.13	(2.76)	15.01	(2.59)	0.99
School rules		16.02	(2.54)	15.97	(2.50)	0.44
Mobile phone dependency		14.85	(4.69)	15.20	(4.69)	1.65

* $p < 0.05$.
** $p < 0.01$.

School adjustment was measured by 10 items of the School Life Adjustment Scale developed by Min (Min, 1991). We used two subscales (scale learning activities and school rules), which consisted of five items each. Higher scores indicate higher levels of school adjustment in each area. Examples of items are as follows: "I always do my homework (learning activity)," "I always put trash in a trash container (school rule)," The Cronbach's alpha coefficients were 0.885 in this study sample.

Data analysis

Data were analyzed using SPSS 22.0 (IBM Corp., Armonk, NY, USA) software. The general characteristics and study variables were assessed using descriptive statistics. A comparison of the measured variables among the two groups (with or without allergic diseases) was analyzed with chi-square (χ^2) and an independent sample *t*-test. The correlation between the measured variables was analyzed by Pearson's correlation coefficient.

The main analysis of the structural equation modeling was conducted using maximum likelihood (ML) estimation by means of AMOS 21.0 (IBM Corp., Armonk, NY, USA). The maximum likelihood estimation method was used for multiple-group structural equation modeling. Since the quality of the fit of the SEM models is affected by sample size, multiple model fit indicators were assessed including χ^2, the ratio of the χ^2 to degrees of freedom (χ^2/df), the normed-fit index (NFI), the Tucker Lewis index (TLI), the comparative fit index (CFI), the goodness of fit index (GFI), the standardized root mean square residual (SRMR), and the root mean squared error of approximation (RMSEA). To conduct multiple-group structural equation modeling, following three hierarchical ordering of constraints for the purpose of multiple group estimation: (1) configural invariance (unconstrained model), (2) measurement invariance, and (3) structural invariance and the cross-group comparability of the model were evaluated by the test of χ^2 differences between nested models (Bentler & Bonett, 1980; Kline, 2005). Multiple-group structural equation modeling was used to test the differences in the critical ratio for the variables depressive symptom, emotional aggression, school adjustment, and mobile phone dependency between adolescents with allergic diseases and those without allergic disease. If the critical ratio for the differences between the two groups is between −1.96 and + 1.96 using pairwise parameter comparison, then the null hypothesis (H0) is accepted; if the critical ratio is beyond −1.96 and + 1.96, then the H0 is rejected.

Table 3
Measurement invariance between adolescents with or without allergic diseases.

Model	χ^2	*df*	*p*	$\Delta\chi^2$	Δdf	*p*
Configural invariance	1027.794	244	<0.001			
Measurement invariance	1039.704	258	<0.001	11.910	14	0.614
Structural invariance	1055.815	263	<0.001	16.111	5	0.007

Ethical considerations

Prior to initiating the study, the study protocol was approved by the institutional review board of the academic institution with which the researcher is affiliated (IRB No. FEUIRB-180823-03-4).

Results

The total sample included 1937 first-year middle school students, 991 boys and 945 girls. Among them, 826 (42.6%) had at least one allergic disease, such as asthma, allergic rhinitis, or atopic dermatitis; 1111 (57.4%) had no allergic disease. The prevalence of allergic diseases was significantly higher in boys than in girls ($\chi^2 = 5.16$, $p < 0.001$).The prevalence of asthma, allergic rhinitis, and atopic dermatitis was 110 (5.7%), 690 (35.6%), and 251 (13.0%), respectively. The differences of the study variables among those with and without allergic disease are presented in Table 1. The level of depressive symptoms ($t = 3.49$, $p < 0.001$) and emotional aggression ($t = 2.32$, $p = 0.020$) was significantly higher in the group with allergic diseases. School adjustment ($t = 0.82$, $p = 0.412$) and mobile phone dependency ($t = 0.99$, $p = 0.099$) showed no significant differences between the two groups. Correlations of the study variables are presented in Table 2. Both groups, with and without allergic disease, showed statistically significant correlations among all the variables.

The skewness and kurtosis of the study variables ranged from −0.76 to 0.25 and −0.60 to 0.52, respectively, indicating normal distribution of the data. Fit indices in the model among the total sample showed that the hypothesized model fits our data well ($\chi^2 = 767.427$, CMIN/DF = 6.395, NFI = 0.953, TLI = 0.949, CFI = 0.960, GFI = 0.956, SRMR = 0.041, RMSEA = 0.053), indicating configural invariance among the two groups. For measurement invariance, the difference in chi-square between the baseline model and constraints of measurement weight was 25.045 ($p = 0.094$), indicating that the measures have the same meaning for the two groups. Consequently, for structural invariance, the delta chi-square between constraints of measurement weights and structural covariance was 14.468 ($p = 0.013$), indicating significantly different path coefficients for the two groups (Table 3).

Two SEMs revealed that depressive symptoms ($\beta = -0.29$, $p < 0.001$; $\beta = -0.20$, $p < 0.001$) and emotional aggression ($\beta = -0.50$, $p < 0.001$; $\beta = -0.30$, $p < 0.001$) were significantly associated with poor school adjustment; depressive symptoms ($\beta = 0.30$, $p < 0.001$; $\beta = 0.07$, $p = 0.022$), emotional aggression ($\beta = 0.20$, $p = 0.001$; $\beta = 0.23$, $p < 0.001$), and poor school adjustment ($\beta = -0.12$, $p < 0.001$; β

Table 2
Correlations of study variables (left = with allergic diseases/right = no allergic disease).

	Depressive symptoms	Emotional aggression	School adjustment	Mobile phone dependency
Depressive symptoms	1.00/1.00			
Emotional aggression	0.60**/0.63**	1.00/1.00		
School adjustment	−0.42**/−0.34**	−0.43**/−0.35**	1.00/1.00	
Mobile phone dependency	0.41**/0.31**	0.41**/0.36**	−0.35**/−0.30**	1.00/1.00

** $p < 0.01$.

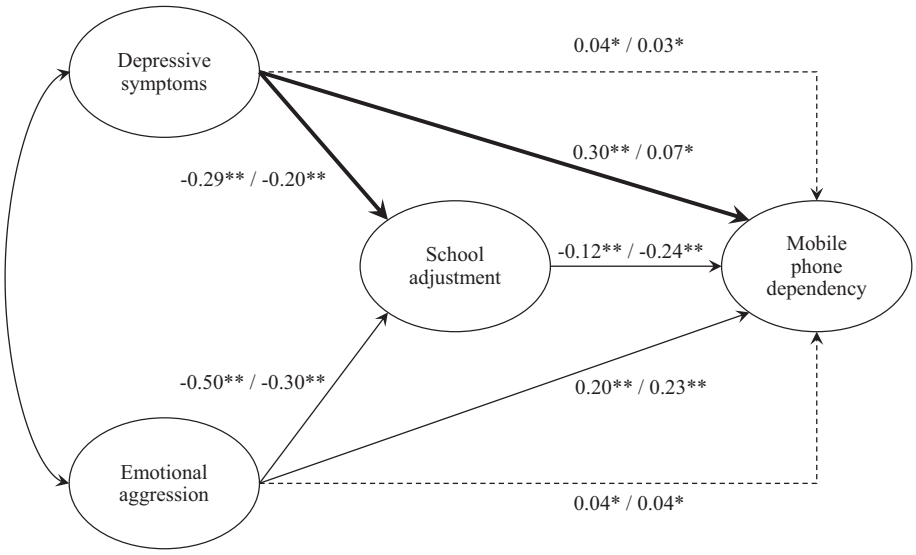

Fig. 1. Multi-group structural equation model of mobile phone dependency between adolescents with and without allergic diseases. Note. Bold arrows indicated different effects across groups; ordinary arrows indicate direct effect; dotted arrows indicate indirect effect; β is presented for the case of with allergic diseases (left) and without allergic diseases (right); error terms are excluded for simplicity.

$= -0.24$, $p < 0.001$) were significantly associated with mobile phone dependency. Significantly higher coefficients were found on the path of depressive symptoms to school adjustment ($Z = 2.048$, $p = 0.040$), and depressive symptoms ($Z = -2.017$, $p = 0.044$) to mobile phone dependency in the group with allergic diseases. These results indicate that more depressive symptoms in adolescents with allergic diseases had a greater negative effect on school adjustment and a more positive effect on mobile phone dependency (Fig. 1, Table 4).

Discussion

This study examined the relationships of depressive symptoms, emotional aggression, school adjustment, and mobile phone dependency among South Korean adolescents with or without allergic diseases, using a multi-group SEM approach. There were differences in the path from depressive symptoms to school adjustment and to mobile phone dependency across the two groups. This study first examined the effects of physical health on mobile phone dependency and the different paths to mobile phone dependency among adolescents with or without allergic diseases. Mobile phone dependency or addiction has received considerable attention in recent times because of the high penetration rate of mobile phones globally, as well as the rapid growth of mobile phone dependency rates (South Korea has one of the highest mobile phone subscription rates in the world (Sohn, 2018) – only 2.8% of the panel data did not own a mobile phone). The excessive use of, and dependency on, mobile phones has emerged as a widespread behavioral problem, especially among teenagers. Since adolescents are the age group most susceptible to mobile phone dependency, several factors – mostly psychological ones – have been reported as influencing mobile phone dependency (Brand et al., 2016). Although psychological and behavioral features in chronic diseases possibly affect mobile phone dependence, scant attention has been paid to users' physical health.

In our study, 42.6% of adolescents reported to have one or more allergic diseases, including allergic rhinitis (35.6%), atopic dermatitis (13.0%), and asthma (5.7%), which is in line with the global prevalence (Dziekanski & Marcelino, 2017; Mallol et al., 2013). In addition to air pollution and industrialization, the adoption of a Western lifestyle has contributed to the increasing prevalence of these allergic diseases among Korean adolescents in recent times (Cho et al., 2014). Western lifestyle is characterized by a high-calorie diet and a deficiency in fiber, lack of physical activity, and long hours spent indoors. In particular, increased exposure to indoor allergens can promote allergic sensitization (Lambrecht & Hammad, 2017; Lang, 2019). These diseases have in common the fact that they are IgE-mediated diseases, chronic conditions without a cure, and a major burden to the affected adolescents. Allergic diseases can cause psychological problems (Chun et al., 2015), and the results of this study show that adolescents with allergic diseases have a higher level of depressive symptoms and emotional aggression. These results could be explained by the experience of psychological stress or frustration due to disease-related symptoms such as limited physical activity and body dissatisfaction (Cho et al., 2014). For example, sleep-disordered breathing, which is commonly experienced in allergic diseases, is one of the factors that causes various psychological and behavioral disorders, such as concentration disorder, memory and learning disorder, and a tendency toward aggression (Greene & Carroll, 1997).

Table 4
Regression weights and differences of critical ratio.

Path	Allergic diseases (n = 826)		No allergic disease (n = 1111)		Differences	
	B (β)	CR	B (β)	CR	Differences of CR	*Z*
Depressive symptoms → School adjustment	−0.54 (−0.29)	−6.13**	−0.29 (−0.20)	−3.47**	−2.66	2.048*
Emotional aggression → School adjustment	−2.01 (−0.50)	−4.79**	−1.59 (−0.30)	−4.83**	0.04	0.777
Depressive symptoms → Mobile phone dependency	0.07 (0.30)	4.78**	0.02 (0.07)	2.29**	2.49	−2.017*
Emotional aggression → Mobile phone dependency	0.25 (0.20)	3.21**	0.24 (0.23)	3.96**	−0.75	−0.081
School adjustment → Mobile phone dependency	−0.04 (−0.12)	−3.48**	−0.05 (−0.24)	−5.36**	1.88	−0.717

CR = critical ratio.
* $p < 0.05$.
** $p < 0.01$.

Although we could not find significant mean differences in school adjustment and mobile phone dependency among adolescents with or without allergic diseases, interestingly, these behavioral problems were more strongly affected by depressive symptoms when an adolescent had an allergic disease. We could not find previous studies comparing these two groups on the overuse of mobile phones, but this behavior is probably a maladaptive coping strategy. Because adolescents with allergic disease are at more risk of psychological distress and limited physical activity (Chun et al., 2015), these stresses could lead adolescents to concentrate more on mobile phones as a means of stress relief. Also, problems such as annoying allergic symptoms, poor sleep quality, absence from school, and poor self-image could intensify the relationship between depressive symptoms and school adjustment when an adolescent has an allergic disease. Therefore, healthcare professionals need to be concerned not only with the physical symptoms of these students, but also with their psychological issues, such as depression, because of allergic diseases (Garg & Silverberg, 2014). Early assessments and interventions for depressive symptoms among adolescents with allergic diseases could help prevent overdependence on mobile phones as well as maladjustment at school. Importantly, the depressive symptoms of adolescents with allergic disease are more likely to lead to behavioral problems (Lee et al., 2015); accordingly, intervention should also address coping strategies that emphasize maintaining effective problem-solving skills and healthy behaviors. Also, behavior problems such as mobile phone dependency should be taken up by healthcare professionals from across all health care settings (e.g., pediatric nurses in acute care, school nurses, etc.).

This study has several limitations. First, because the original data did not include a detailed description of disease characteristics, we were unable to analyze the exact diagnosis or severity of the disease. For example, an adolescent who had been diagnosed with an allergic disease by a physician and was well controlled with minimal symptoms would be classified in the group with allergic diseases. On the contrary, as the questionnaires featured questions regarding diagnosis, such as "allergic rhinitis," and not the symptoms of these conditions, some adolescents may not have known the name of their disease and could be classified in the group without allergic diseases. However, this questionnaire was completed after a review by experts and a pilot study, and these methodological issues would pose minimal problems. Therefore, future studies are necessary to examine the relationships between mobile phone dependency and clinical features such as symptom severity and level of IgE. Second, since the current study was cross-sectional, we could not rule out reverse causality. Further longitudinal studies, including detailed clinical data and mediated factors such as coping strategies are therefore required to confirm the causality. Nevertheless, this study, based on nationally representative and large sample data, has deepened our understanding of the relationship between depressive symptoms, aggression, school adjustment, and mobile phone dependency, and the different efficiency of the paths among adolescents with or without allergic diseases.

Taken together, mobile phone dependency is affected by depressive symptoms, emotional aggression, and school adjustment in adolescents both with and without allergic disease, as we know. Interestingly, depressive symptoms in adolescents with allergic disease are more likely to affect behavioral problems such as school adjustment and mobile phone dependency than in those without such disease. Therefore, the depressive symptoms of adolescents with allergic disease require more attention, and interventions should be provided to relieve their emotional stress and prevent maladjustment at school and overdependence on mobile phones that may have been previously neglected.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

CRediT authorship contribution statement

Juyeon Oh: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Resources, Data curation, Writing - original draft, Writing - review & editing, Visualization, Project administration. **Jiwon An:** Conceptualization, Methodology, Validation, Investigation, Resources, Writing - original draft, Writing - review & editing, Visualization, Project administration.

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