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Lower-Income Predicts Increased Smartphone Use and Problematic Behaviors Among Schoolchildren During COVID-19 Related School Modification: A Longitudinal Study

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ABSTRACT

Background: As the coronavirus disease 2019 (COVID-19) has continued for a couple of years, the long-term effects of the pandemic and the subsequent school curriculum modification on the mental health of children and parents need to be investigated. To clarify the changes that can occur during one school year and to predict the risk factors for vulnerable groups, this study identified parameters relative to children's screen time, their problematic behavior, and parental depression.

Methods: A total of 186 participants were analyzed who were parents of elementary schoolchildren in South Korea. These parents were required to complete a web-based questionnaire twice. The questionnaires were conducted in June 2020 and September 2021. Participants' general demographics including family income, children's screen time, sleep patterns, problematic behavior, and parental depression were assessed via the parental questionnaire that included various measurement tools.

Results: Children's body mass index (BMI) increased significantly in 2021 (18.94 ± 3.75 vs. 18.14 ± 3.30, $P < 0.001$). Smartphone frequency of use per week (5.35 vs. 4.54, $P < 0.001$) and screen time per day (3.52 vs. 3.16, $P < 0.001$) significantly increased during the period of the COVID-19 pandemic. The television screen time (2.88 vs. 3.26, $P < 0.001$), frequency of viewing (3.77 vs. 4.77, $P < 0.001$), and children's problematic behaviors significantly decreased (9.15 vs. 11.85, $P < 0.001$). A lower income household was a key predictor of increased smartphone frequency (B = 1.840, 95% confidence interval [CI], 0.923–2.757, $P < 0.001$) and smartphone screen time (B = 1.992, 95% CI, 1.458–2.525, $P < 0.001$). The results showed that the lower income household (B = 5.624, 95% CI, 2.927–8.320, $P < 0.001$) and a child's psychiatric treatment history (B = 7.579, 95% CI, 5.666–9.492, $P < 0.001$) was the most significant predictor of problematic behaviors of children and parental depression (B = 3.476, 95% CI, 1.628–5.325, $P < 0.001$; B = 3.138, 95% CI, 1.827–4.450, $P < 0.001$).

Conclusion: This study suggested that children's smartphone screen time and BMI increased during COVID-19 because of the school curriculum modification following school closures in South Korea. The increased children's problematic behaviors and parental depression were predicted by lower-income households and the previous psychiatric history of children.

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These results indicate that multiple social support systems to the vulnerable group are needed during the ongoing pandemic and that a modified school setting is required.

Keywords: Longitudinal Study; Covid-19; School; Screen Time; Child Behavior

INTRODUCTION

The emergence of the coronavirus disease 2019 (COVID-19) has evoked an interest in research concerning its psychological impact in addition to it being a global health crisis.[1-4] Following the outbreak of the COVID-19 pandemic, many countries implemented social distancing measures such as stay-at-home orders, which in turn affected the daily lives of people worldwide. According to a UNESCO report in March 2020,[5] more than 90% of the world's schools have been temporarily closed to mitigate the spread of COVID-19. In South Korea, the government implemented social distancing measures from March 2020. Part of these measures involved elementary school classes being offered online as a form of home-based learning. With growing concern about the interrupted learning and students' opportunities for growth and developmental loss due to the lack of teacher-child, inter-colleagues interaction, and reduced role tasks, a hybrid model was started in June 2020.[6,7] A hybrid model was school modification which combined online and full in-person class because the number of students attending school had to be adjusted according to the density. After it changed, children were required to physically attend school one to three days a week, depending on school size and their school year, and engage in home-based learning for the remaining weekdays. At school, children were seated separately and asked to keep their masks on and minimize their conversations with classmates.

The children who are going through developmental milestones (physical, language, social and moral) would experience the effects of physical and social isolation on an even greater scale.[8] Failure to go to school, social isolation, increased screen time, and parental stress are likely to negatively affect children's mental health.[8-10] Interaction with peers and support from families are powerful aids for children, but the COVID-19 pandemic has also hindered them. Impoverished children, who may rely heavily on school-based services were disproportionately impacted.[11,12] Thus, specific studies are needed to determine which groups are more vulnerable to specific elements of the crises and to determine how they may respond to those long-term changes.

Recently, many studies have been conducted on the effects of these social changes on adult mental health, such as a lockdown or longitudinal changes that compared pre- and post-pandemic mental health statuses.[13-17] Although the pandemic has lasted for more than two years, the long-term impact of COVID-19 is still unclear. A longitudinal study of 7,319 Americans reported that psychological distress rose sharply during the early days of COVID-19 and returned to its original baseline after 3 months,[18] however, another study argued the population in vulnerable groups were more susceptible to mental health issues during the pandemic.[19] In contrast, there are few studies of the impact on children. Therefore, it became necessary to study how the children's mental health changed from the initial stage to the current stage of the pandemic.[20]

In this study, the primary purpose was to elucidate if there had been any change in children's and parental mental health problems during the various stages of COVID-19. This was done

by comparing their mental health levels or statuses at the time of the initial school closures and 14 months after the hybrid school modification was implemented. In terms of the children's screen time, behavior problems, sleep problems, and parental depression. The secondary purpose was to identify the various predictors of those potential changes in a longitudinal setting among Korean elementary students during the COVID-19 related school curriculum modifications.

METHODS

Study design and participants

This study was conducted online and completed by the randomly recruited children's caregivers via emailed link in South Korea. They accessed the web page through an e-mailed link and provided informed consent, reviewed the research guide, and completed the questionnaire.

Using a longitudinal study, surveys were disseminated to a caregiver at two-time points during COVID-19: once at the end of school closures and at the beginning of the hybrid school model (June 2020) and 14 months later during the hybrid or full in-person classes model (September 2021). Earlier data was collected from June 1st to June 30th, 2020, approximately three months after the online-only curriculum (school closure) was implemented in South Korea. The baseline investigations were published that parental subjective stress and depression were strongly and positively associated with children's sleep problems, media exposure, and problem behaviors.[13] The second survey was conducted from September 17th to October 31st, 2021. It was one year after the announcement of a full in-person class was decided. From March 2021, in-person classes were strongly implemented in many elementary schools for grades 1 and 2 children. The combination of online and offline classes was implemented for children in grades 3 and above. For an accurate analysis, there is a strong need for timely longitudinal research that allows a direct comparison of mental health during the school curriculum modifications due to COVID-19 using validated mental health scales to avoid potential errors.[21-24]

A total of 186 caregivers of elementary school children from community mental health centers in Suwon City, South Korea were randomly recruited. Among participants, the 84 children who had already participated in the Kids Cohort for Understanding of Internet Addiction Risk Factors in Early Childhood (K-CURE) study. Except for 18 people from 9 households, independent families participated. Participants who met inclusion criteria and completed the survey got compensation ($5 worth of hygiene products such as masks). The inclusion criteria were: 1) parents who completed both surveys, 2) parents of primary school children, 3) parents who were able to read and write in Korean.

Measures

Screen time variables

Screen time was investigated by asking primary daytime caregivers to report the frequency per week and time per day of their children's screen time including television (TV), tablet personal computer (PC), and smartphone in line with the recommendations of previous studies.[13,25] According to the frequency of use, a request was made to select the number of days each device was used for 1 week. The response options for the mean length of time per day the media were accessed, and the corresponding coded scores were as follows: none

(score: 0; less than 1 hour (score: 1); more than 1 hour and less than 2 hours (score: 2); more than 2 hours and less than 3 hours (score: 3); more than 3 hours and less than 4 hours (score: 4); and more than 4 hours (score: 5).

Children's sleep and behavioral problems
Children's sleep problems were assessed through the parents completing a short version of the Children's Sleep Habits Questionnaire (CSHQ), proven useful in a previous study.[13] Parents were asked to recall the sleeping behaviors of their children that occurred over a typical week. Item scores were summed to create a score that could range from 0–12, with higher scores representing greater sleep problems.

Behavioral problems were assessed with the Behavior Problem Index (BPI),[26] developed by James L. Peterson, Nicholas Zill,[27] and Thomas Achenbach.[28] It consists of 27–28 items, 23 common questions and 5 additional questions for those under the age of 11, and 4 additional questions for those over 12. It composed with six domains: "Anxious/Depressed," "Headstrong," "Hyperactive," "Immature Dependency," "Anti-social," and "Peer Conflict/Social Withdrawal." The ratings relied on feedback by caregivers as they were asked to rate their children using a three-point Likert-type scale (0 = not true, 1 = sometimes true, 2 = often true). These questions assess specific behaviors that children may have exhibited in the previous three months. In the current study, Cronbach's α was .090–.092 in BPI.

Parental mental health (depression)
The Patient Health Questionnaire (PHQ-9) was used similarly as it was in a previous study. Participants were asked to rate nine questions relating to depressive symptoms that they may have experienced in the past two weeks: 0 (not at all), 1 (several days), 2 (more than half the days), or 3 (nearly every day). In the current study, Cronbach's α was .0895–.0916 in PHQ-9.

Family income
Household income was assessed with the question "What is your *current* average monthly household income?" Caregivers chose from the following response options: "less than $1,700 (two million Korean won, 2M KRW)," "$1,700 (2M KRW) to $3,400 (4M KRW)," "$3,400 (4M KRW) to $5,000 (6M KRW)," and "over $5,000 (6M KRW)." The income level was divided based on 4 million won (approximately $3,400) by referring to the median national income.

Statistical analyses
Variables were summarized via descriptive statistics for demographic information, including frequencies, means, and standard deviations. To compare the differences of mean scores by year, paired t-tests were used. Regression analysis was used to test whether baseline demographic variables predict the variables for those in the year 2021. However, since the normality of the population could not be assumed, the generalized estimating equation (GEE) was applied. GEE was performed with all predictors when they were entered initially. All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 25.0 (SPSS Inc., Chicago, IL, USA), and a *P* value of < 0.05 was considered statistically significant.

Ethics statement
This study was approved by the Institutional Review Board (IRB) at the Ajou University School of Medicine, Suwon City, South Korea (IRB No. AJIRB-SBR-SUR-21-345). Informed consent was obtained from all participants at two times of enrollment. Data were collected

through a web-based questionnaire platform. Participants could withdraw from the survey at any time without justification.

RESULTS

Descriptive statistics of participants

The characteristics of the participants in 2021 and 2020 are shown in **Table 1**. A total of 186 participants (85.7% response rate) were included in the data analysis. The participant's mean age was 10.14 years old with a range of 8 to 13 years. Body mass index (BMI) increased significantly in 2021 (18.94 ± 3.75 vs. 18.14 ± 3.30, $P < 0.001$). However, there was no statistically significant difference in the monthly household income in 2021 and 2020 ($P = 0.063$). Previous mental health care services that the children were evaluated, and 26.3% of them had a history of psychiatric treatment at both survey time points. Fifteen of these students (8.1%) are in grades 1–2 of elementary school who had attended complete in-person classes without online classes in 2021.

Screen time, sleep and behavioral problems in 2021 and 2020

The changes in the children's screen time, sleep behaviors, and behavioral problems from the longitudinal study are shown in **Table 2**. Compared to 2020, smartphone screen time, tablet PC screen time per day (respectively, $P < 0.001$), and smartphone usage frequency per week ($P < 0.001$) increased significantly in 2021. Contrastingly, the TV usage time and frequency showed a tendency to decline ($P < 0.001$).

The children's problematic behavior scores were significantly decreased ($P < 0.001$) from 11.85 to 9.15 between 2020 and 2021. There was no significant change in children's sleep problems as reported by their parents, or in a parental depression between 2020 and 2021.

To understand the effect of in-person classes, the researchers divided the cross-sectional data for 2021 into two groups according to the grade the children are in (full in-person classes for grades 1–2 vs. hybrid classes for grades 3 and above) to see if there was a difference between

Table 1. Demographic characteristics of study participants in 2020 and 2021

Variables	2020 (n = 217)	2021 (n = 186)
Sex, female	95 (43.8)	82 (44.1)
Age, yr	9.16 ± 1.43	10.14 ± 1.44
Body mass index[a]	18.14 ± 3.30	18.94 ± 3.75
Caregiver		
Mother	194 (89.4)	171 (91.9)
Others	23 (10.6)	15 (8.1)
Monthly household income		
< $1,700	36 (16.6)	33 (17.7)
−$3,400	81 (37.3)	57 (30.6)
−$5,000	65 (30.0)	58 (31.2)
> $5,000	35 (16.1)	38 (20.4)
Previous received mental health service		
Yes	57 (26.3)	49 (26.3)
No	160 (73.7)	137 (73.7)
School class model		
Full in-person (1st and 2nd grades)	All participants had begun	15 (8.1)
Hybrid class (3rd and higher grades)	hybrid class	171 (91.9)

Values are presented as number (%) or mean standard ± deviation.
[a]indicate statistically significant ($P < 0.001$).

Table 2. Screen time and behavioral problems in 2020 and 2021 (n = 186)

Variables	2020	2021	MD	T value	P value
Screen time variables					
Smartphone frequency per week	4.54	5.35	0.81	4.13	< 0.001
Smartphone screen time per day	3.16	3.52	0.37	3.69	< 0.001
Tablet PC frequency per week	3.44	3.77	0.34	1.41	0.160
Tablet PC screen time per day	2.72	3.22	0.50	3.76	< 0.001
TV frequency per week	4.77	3.77	−1.00	−5.43	< 0.001
TV screen time per day	3.26	2.88	−0.39	−4.09	< 0.001
Children's variables					
Sleep Problem Score (CSHQ)	3.67	3.59	0.75	0.47	0.641
Problematic Behavior Score (BPI)	11.85	9.15	−2.71	−5.55	< 0.001
Parents' variables					
Depression Score (PHQ-9)	5.06	5.59	0.53	1.62	0.106

CSHQ = Children's Sleep Habits Questionnaire, BPI = Behavior Problem Index, PHQ-9 = Patient Health Questionnaire-9.

them. Through a Mann-Whitney analysis, no difference was found between the children in these groups according to the school modification.

Predictors for screen time and subject's variables by GEE analysis

This study examined which variables, if any, from the year 2020 could be used to predict screen time in 2021 (**Table 3**). To understand past predictors, a GEE analysis was performed.

Lower-income (income level 1, less than $1,700 per month) was found to be a significant predictor in 2020, for both smartphone usage frequency per week (B = 1.840, 95% Wald confidence interval [CI], 0.923–2.757, P < 0.001) and smartphone screen time per day (B = 1.992, 95% Wald CI, 1.458–2.525, P < 0.001) in 2021. The income level 2 ($1,700–$3,400 per month) predicted the smartphone screen time per day (B = 0.699, 95% Wald CI, 0.230–1.16, P = 0.003). In terms of decreasing TV usage time, all income levels except the highest in 2020 significantly predicted the TV screen time in 2021.

Additionally, the researchers also examined which variables of 2020 potentially predicted children's problematic behavior and parental depression in 2021 (**Table 4**). In children's problematic behavior, lower-income groups (income level 1, B = 5.624, 95% Wald CI, 2.927–8.320, P < 0.001; income level 2, B = 5.023, 95% Wald CI, 2.652–7.394, P < 0.001) and children's previously received mental health care services in 2020 (B = 7.579, 95% Wald CI, 5.666–9.492, P < 0.001) were significant predictors. In parental depression, lower-income groups (income level 1, B = 3.476, 95% Wald CI, 1.628–5.325, P < 0.001; income level 2, B = 1.807, 95% Wald CI, 0.181–3.243, P = 0.029) and children's previously received mental health care services were significant predictors (B = 3.138, 95% Wald CI, 1.827–4.450, P < 0.001).

DISCUSSION

There was an increase in the children's BMI in 2021. Insufficient outdoor physical activity has been suggested as a major risk factor for overweight pediatric or obesity development.[29] It also provided that excessive weight gain in children mainly occurred during the summer, while they were not going to school.[30]

Previous Korean studies showed the COVD-19 pandemic influence on the increasing childhood obesity rates.[31] Specifically, a hospital clinic sample found that being normal range

Table 3. Predictors for media usage by generalized estimating equation analysis

Screen time variables (2021)	Predictors (2020)	B	SE	95% Wald CI	P value
Smartphone frequency per week	Sex: male	−0.231	0.273	−0.766, 0.304	0.397
	Main caregiver: mother	−0.014	0.425	−0.849, 0.820	0.973
	Income level = 1	1.840	0.468	0.923, 2.757	**< 0.001*****
	Income level = 2	0.449	0.411	−0.357, 1.256	0.275
	Income level = 3	−0.017	0.397	−0.794, 0.760	0.966
	Psychiatric treatment	0.247	0.418	−0.571, 1.066	0.554
Smartphone screen time per day	Sex: male	0.162	0.159	−0.149, 0.474	0.308
	Main caregiver: mother	0.325	0.248	−0.160, 0.811	0.189
	Income level = 1	1.992	0.272	1.458, 2.525	**< 0.001*****
	Income level = 2	0.699	0.239	0.230, 1.160	**0.003****
	Income level = 3	−0.050	0.231	0.502, 0.403	0.830
	Psychiatric treatment	−0.204	0.193	−0.582, 0.175	0.292
Tablet PC frequency per week	Sex: male	0.141	0.302	−0.451, 0.734	0.641
	Main caregiver: mother	−0.056	0.471	−0.979, 0.868	0.906
	Income level = 1	−0.003	0.518	−1.019, 1.012	0.995
	Income level = 2	0.263	0.455	−0.630, 1.156	0.564
	Income level = 3	0.162	0.439	−0.698, 1.023	0.712
	Psychiatric treatment	0.389	0.368	−0.331, 1.110	0.289
Tablet PC screen time per day	Sex: male	0.086	0.181	−0.268, 0.440	0.634
	Main caregiver: mother	0.234	0.281	−0.317, 0.785	0.405
	Income level = 1	0.389	0.309	−0.217, 0.995	0.209
	Income level = 2	0.427	0.272	−0.106, 0.960	0.117
	Income level = 3	0.084	0.262	−0.430, 0.598	0.748
	Psychiatric treatment	0.123	0.219	−0.307, 0.553	0.574
TV frequency per week	Sex: male	−0.226	0.270	−0.756, 0.303	0.402
	Main caregiver: mother	−0.420	0.421	−1.246, 0.405	0.318
	Income level = 1	0.201	0.463	−0.706, 1.109	0.664
	Income level = 2	0.407	0.561	−0.319, 1.276	0.240
	Income level = 3	0.500	0.392	−0.269, 1.269	0.202
	Psychiatric treatment	−0.019	0.328	−0.663, 0.625	0.954
TV screen time per day	Sex: male	−0.084	0.128	−0.334, 0.166	0.512
	Main caregiver: mother	−0.212	0.199	−0.601, 0.178	0.287
	Income level = 1	0.756	0.219	0.327, 1.184	**0.001****
	Income level = 2	0.675	0.192	−0.298, 1.051	**< 0.001*****
	Income level = 3	0.477	0.185	0.114, 0.841	**0.009****
	Psychiatric treatment	−0.267	0.155	−0.571, 0.037	0.085

CI = confidence interval.
Income level: 1 = less than $1,700; 2 = between $1,700–$3,400; 3 = between $3,400–$5,000; 4 = more than $5,000 per month.
**Significant at P < 0.01, ***Significant at P < 0.001.

weight was a significant risk factor for increased BMI during school closures, meaning that normal weighted children are more likely to gain weight because of being less alert compared to overweight and obese children about weight gain.[31] The duration of school closures was a significant risk factor for increased BMI. They suggested that reopening schools as soon as possible should be a priority for policymakers and should circumstances following the COVID-19 pandemic make school closure indefinite, interventions should be a focused on ways to increase opportunities for physical activity. Unfortunately, this study showed that after reopening the school, within at least one school year was not quick enough and consequently did not prevent the children's BMI increase. More quantitative and qualitative research on the effects of the changes in the school curriculums and limited outdoor activities has become more urgent than ever before.

Smartphone frequency of use and time spent on devices showed a significant increase in 2021. Despite the full-in person or hybrid classes being possible as compared to 2020 when only full-online classes took place. It reflected the increased use of technology in daily life

Table 4. Predictors for children's problematic behavior and parent's depression by Generalized Estimating Equation

Variables	Predictors (2020)	B	SE	95% Wald CI	P value
Children's variables (2021)					
Sleep Problem Score (CSHQ)	Sex: male	−0.292	0.220	−0.724, 0.140	0.185
	Main caregiver: mother	−0.231	0.343	0.904, 0.442	0.501
	Income level = 1	−0.514	0.377	−1.254, 0.226	0.173
	Income level = 2	−0.170	0.332	−0.820, 0.481	0.609
	Income level = 3	0.360	0.320	−0.267, 0.987	0.260
	Psychiatric treatment	0.262	0.268	−0.263, 0.787	0.328
Problematic Behavior Score (BPI)	Sex: male	−0.210	−0.803	−1.784, 1.364	0.794
	Main caregiver: mother	−1.286	1.251	−3.738, 1.167	0.304
	Income level = 1	5.624	1.378	2.927, 8.320	**< 0.001*****
	Income level = 2	5.023	1.210	2.652, 7.394	**< 0.001*****
	Income level = 3	0.500	1.166	−1.786, 2.785	0.668
	Psychiatric treatment	7.579	0.976	5.666, 9.492	**< 0.001*****
Parent's variables (2021)					
Parent Depression Score (PHQ-9)	Sex: male	−0.839	0.551	−1.918, 0.240	0.128
	Main caregiver: mother	−0.461	0.858	−2.142, 1.220	0.591
	Income level = 1	3.476	0.943	1.628, 5.325	**< 0.001*****
	Income level = 2	1.807	0.829	0.181, 3.432	**0.029***
	Income level = 3	0.291	0.800	−1.276, 1.858	0.716
	Psychiatric treatment	3.138	0.669	1.827, 4.450	**< 0.001*****

CI = confidence interval, CSHQ = Children's Sleep Habits Questionnaire, BPI = Behavior Problem Index, PHQ-9 = Patient Health Questionnaire-9.
*significant at P < 0.05, ***significant at P < 0.001.
Income level: 1 = less than $1,700; 2 = between $1,700–$3,400; 3 = between $3,400–$5,000; 4 = more than $5,000 per month.

for academic work, interpersonal meetings, and entertainment purposes.[32] However, as the age of the children increases, the frequency and time of media use also increase, and the preferred media pattern changes.[33] Additionally, this tendency has been confirmed to occur even if the closure is only for one school year, a long-term study is required.[10,20]

Interestingly, the COVID-19 that lasted for a couple of years showed a relatively adaptive aspect unlike the initial period in terms of problem behaviors of children. Although the main caregiver's level of depression did not change, the children's problematic behaviors decreased significantly. According to earlier studies, screen time was closely related to children's sleep and behavioral problem.[34] However, this study showed that children's sleep problems did not worsen in 2021; this might be due to the reopening of schools that allow them to relearn their previous regular morning routines and assisted in the prevention of the children's sleep problems due to overnight smartphone use. This contradictory finding could be interpreted in a similar context as the results of previous studies that suggested the trajectory of recovery and adaptation.[18]

Contradicting other findings, the depression of the primary caregiver did not significantly increase during the survey period. Contrary to general expectations, reopening schools did not affect parental depression in this study. It is estimated that there were limitations and deterioration in the quality of the interaction in the class curriculum and extra-curricular activities.[15]

In the current study, there were no differences in sleep and behavioral problems between children who attended full in-person classes and hybrid classes according to the administration's density restrictions. One explanation is that younger children might need more quality interpersonal interactions than older children to keep up to date with their developmental milestones and to maintain their mental health.

Since demographic factors such as gender, primary caregiver, income level, children's screen time, along with the mental health of caregivers can all be important predictors for

mental health, the researchers examined whether those variables from 2020 could predict changes in children's screen time and behaviors in 2021. The results showed that when considered within the context of school closures, which was affected by the COVID-19 pandemic, the lower-income household groups were more useful predictors of smartphone usage and parental depression compared to the higher-income household groups during school curriculum modification periods. In addition to lower-income, children's psychiatric treatment history predicted the increased children's problematic behaviors and parental depression. However, the scores of sleep problems and TV usage did not increase.

In the study, the lower-income household groups in 2020 were more predictive of smartphone usage and parental depression in 2021 compared to the higher income household group. The detrimental effects of COVID-19 are more harmful to low-income families, particularly their children. Given that elementary schoolchildren are not mature enough to effectively moderate behavior on their own, they might be less able to control their smartphone usage.[35] Additionally, due to the COVID-19-related online education requirements, their smartphone use may have increased. Many students may become overly reliant on smartphones, even if their parents supervised their usage.

For a low-income household, because the parent job could require them to work on-site, parents might have fewer opportunities to work from home and stay with their children. And the detrimental economic effect of COVID-19 has made it more challenging to earn a living.[35] These all contribute to possibly an increase in the time they have to put in for work to maintain a similar level of income generated before the pandemic. That is, in low-income households, parents may not have enough time to manage their children's smartphone use. It could lead to an increased risk of smartphone addiction among low-income children.

These results are consistent with the results of previous studies showing that the low-income class was vulnerable to media overuse, sleep problems, and problematic behavior.[15,25,34,36] Family income, not only parental wellbeing, but access to an abundant resource of structured education and activity, is an important factor in establishing and maintaining a family's effective coping strategy.[37] However, how income affects other variables during COVID-19 needs to be investigated in detail through additional research.

In addition to lower-income households, the study showed that children's psychiatric treatment history predicted an increase in children's problematic behaviors and parental depression. It was found that the children groups with a history of prior psychiatric treatment for problem behavioral problems had a greater vulnerability to problem behaviors and parental depression.[38] Accordingly, investment of resources will be required not only in the low-income group but in the group of children who received previous psychiatric treatment. Researchers have also found that socioeconomic status may be associated with depression among children and adolescents, even during the COVID-19 pandemic.[39,40]

Strengths of the present study include the repeated assessment measures on the same group in South Korea during COVID-19. It was possible to check which predictors influence media use and children's behavior. Through this, it was possible to examine the difference in resilience levels in other population groups emerging from the sample group. Like how low-income or previous psychiatric treatment history groups have a greater vulnerability to negative influences. However, this study has the following limitations. First, although it is a longitudinal study, it could not be compared with the baseline of the sample before

the pandemic. Second, selection bias could influence the results as the data consisted of voluntary participants who received incentives for their participation. Third, since the income range was divided into certain sections based on self-report measures, there may be a difference in whether or not they are eligible for basic benefits that require government subsidies. Fourth, there was no significant observation found between hybrid and full in-person classes using Mann-Whitney analysis in 2021. These results were thought to be due to the large difference in the number of subjects. The full in-person class has 15 students and the hybrid school group has 171 students.

In summary, this study provides evidence that the COVID-19 pandemic during a year's review led to the increase in screen time but problem behaviors of children have decreased compared to the initial period generally. Income level was a significant predictor, and it was found that screen time and problem behavior increased specifically in the low-income group. Therefore, it is necessary to continue monitoring the mental health of vulnerable groups and ensure that social support is continuously provided, to assist the primary caregiver.

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REFERENCES

1. Luo M, Guo L, Yu M, Jiang W, Wang H. The psychological and mental impact of coronavirus disease 2019 (COVID-19) on medical staff and general public: a systematic review and meta-analysis. *Psychiatry Res* 2020;291:113190.
   PUBMED | CROSSREF

2. Prati G, Mancini AD. The psychological impact of COVID-19 pandemic lockdowns: a review and meta-analysis of longitudinal studies and natural experiments. *Psychol Med* 2021;51(2):201-11.
   PUBMED | CROSSREF

3. Breslau J, Roth EA, Baird MD, Carman KG, Collins RL. A longitudinal study of predictors of serious psychological distress during COVID-19 pandemic. *Psychol Med*. Forthcoming 2021. DOI: 10.1017/S0033291721004293.
   PUBMED | CROSSREF

4. Pfefferbaum B, North CS. Mental health and the Covid-19 pandemic. *N Engl J Med* 2020;383(6):510-2.
   PUBMED | CROSSREF

5. UNESCO. Education, from disruption to recovery. https://en.unesco.org/covid19/educationresponse. Updated 2022. Accessed March 4, 2022.

6. Ministry of Education. Student health information center. COVID-19 guideline in school settings (2-1th edition). http://www.schoolhealth.kr/web/bbs/selectNewBBSList.do?lstnum1=3041. Updated 2020. Accessed March 4, 2022.

7. Choi J, Park Y, Kim HE, Song J, Lee D, Lee E, et al. Daily life changes and life satisfaction among Korean school-aged children in the COVID-19 pandemic. *Int J Environ Res Public Health* 2021;18(6):3324.
   PUBMED | CROSSREF

8. Marques de Miranda D, da Silva Athanasio B, Sena Oliveira AC, Simoes-E-Silva AC. How is COVID-19 pandemic impacting mental health of children and adolescents? *Int J Disaster Risk Reduct* 2020;51:101845.
   PUBMED | CROSSREF

9. Schmidt SC, Anedda B, Burchartz A, Eichsteller A, Kolb S, Nigg C, et al. Physical activity and screen time of children and adolescents before and during the COVID-19 lockdown in Germany: a natural experiment. *Sci Rep* 2020;10(1):21780.
   PUBMED | CROSSREF

10. Montag C, Elhai JD. Discussing digital technology overuse in children and adolescents during the COVID-19 pandemic and beyond: on the importance of considering affective neuroscience theory. *Addict Behav Rep* 2020;12:100313.
    PUBMED | CROSSREF

11. Masonbrink AR, Hurley E. Advocating for children during the COVID-19 school closures. *Pediatrics* 2020;146(3):e20201440.
    PUBMED | CROSSREF

12. Jiao WY, Wang LN, Liu J, Fang SF, Jiao FY, Pettoello-Mantovani M, et al. Behavioral and emotional disorders in children during the COVID-19 epidemic. *J Pediatr* 2020;221:264-266.e1.
    PUBMED | CROSSREF

13. Kim SJ, Lee S, Han H, Jung J, Yang SJ, Shin Y. Parental mental health and children's behaviors and media usage during COVID-19-related school closures. *J Korean Med Sci* 2021;36(25):e184.
    PUBMED | CROSSREF

14. Ramiz L, Contrand B, Rojas Castro MY, Dupuy M, Lu L, Sztal-Kutas C, et al. A longitudinal study of mental health before and during COVID-19 lockdown in the French population. *Global Health* 2021;17(1):29.
    PUBMED | CROSSREF

15. Poulain T, Meigen C, Sobek C, Ober P, Igel U, Körner A, et al. Loss of childcare and classroom teaching during the Covid-19-related lockdown in spring 2020: a longitudinal study on consequences on leisure behavior and schoolwork at home. *PLoS One* 2021;16(3):e0247949.
    PUBMED | CROSSREF

16. Kwong AS, Pearson RM, Adams MJ, Northstone K, Tilling K, Smith D, et al. Mental health before and during the COVID-19 pandemic in two longitudinal UK population cohorts. *Br J Psychiatry* 2021;218(6):334-43.
    PUBMED | CROSSREF

17. Okely AD, Kariippanon KE, Guan H, Taylor EK, Suesse T, Cross PL, et al. Global effect of COVID-19 pandemic on physical activity, sedentary behaviour and sleep among 3- to 5-year-old children: a longitudinal study of 14 countries. *BMC Public Health* 2021;21(1):940.
    PUBMED | CROSSREF

18. Daly M, Robinson E. Psychological distress and adaptation to the COVID-19 crisis in the United States. *J Psychiatr Res* 2021;136:603-9.
    PUBMED | CROSSREF

19. Holmes EA, O'Connor RC, Perry VH, Tracey I, Wessely S, Arseneault L, et al. Multidisciplinary research priorities for the COVID-19 pandemic: a call for action for mental health science. *Lancet Psychiatry* 2020;7(6):547-60.
    PUBMED | CROSSREF

20. Wade M, Prime H, Browne DT. Why we need longitudinal mental health research with children and youth during (and after) the COVID-19 pandemic. *Psychiatry Res* 2020;290:113143.
    PUBMED | CROSSREF

21. Daly M, Sutin AR, Robinson E. Longitudinal changes in mental health and the COVID-19 pandemic: evidence from the UK Household Longitudinal Study. *Psychol Med*. Forthcoming 2020. DOI: 10.1017/S0033291720004432.
    PUBMED | CROSSREF

22. Meda N, Slongo I. Caution when linking COVID-19 to mental health consequences. *Brain Behav Immun* 2020;87:152.
    PUBMED | CROSSREF

23. Pierce M, Hope H, Ford T, Hatch S, Hotopf M, John A, et al. Mental health before and during the COVID-19 pandemic: a longitudinal probability sample survey of the UK population. *Lancet Psychiatry* 2020;7(10):883-92.
    PUBMED | CROSSREF

24. Pierce M, McManus S, Jessop C, John A, Hotopf M, Ford T, et al. Says who? The significance of sampling in mental health surveys during COVID-19. *Lancet Psychiatry* 2020;7(7):567-8.
    PUBMED | CROSSREF

25. Lee S, Kim S, Suh S, Han H, Jung J, Yang S, et al. Relationship between screen time among children and lower economic status during elementary school closures due to the coronavirus disease 2019 pandemic. *BMC Public Health* 2022;22(1):160.
    PUBMED | CROSSREF

26. Craig BM, Brown DS, Reeve BB. Valuation of child behavioral problems from the perspective of US adults. *Med Decis Making* 2016;36(2):199-209.
    PUBMED | CROSSREF

27. Zill JL. Marital disruption, parent-child relationships, and behavior problems in children. *J Marriage Fam* 1986;48(2):295-307.

28. Achenbach TM, Edelbrock CS. Behavioral problems and competencies reported by parents of normal and disturbed children aged four through sixteen. *Monogr Soc Res Child Dev* 1981;46(1):1-82.
   PUBMED | CROSSREF

29. Sultana S, Rahman MM, Sigel B, Hashizume M. Associations of lifestyle risk factors with overweight or obesity among adolescents: a multicountry analysis. *Am J Clin Nutr* 2021;113(3):742-50.
   PUBMED | CROSSREF

30. Franckle R, Adler R, Davison K. Accelerated weight gain among children during summer versus school year and related racial/ethnic disparities: a systematic review. *Prev Chronic Dis* 2014;11:E101.
   PUBMED | CROSSREF

31. Kang HM, Jeong DC, Suh BK, Ahn MB. The impact of the coronavirus disease-2019 pandemic on childhood obesity and vitamin D status. *J Korean Med Sci* 2021;36(3):e21.
   PUBMED | CROSSREF

32. Limone P, Toto GA. Psychological and emotional effects of digital technology on children in COVID-19 pandemic. *Brain Sci* 2021;11(9):1126.
   PUBMED | CROSSREF

33. Lee DY, Roh HW, Kim SJ, Park EJ, Yoo H, Suh S, et al. Trends in digital media use in Korean preschool children. *J Korean Med Sci* 2019;34(41):e263.
   PUBMED | CROSSREF

34. Choi Y, Lee DY, Lee S, Park EJ, Yoo HJ, Shin Y. Association between screen overuse and behavioral and emotional problems in elementary school children. *Soa Chongsonyon Chongsin Uihak* 2021;32(4):154-60.
   PUBMED | CROSSREF

35. Lee J, Lim H, Allen J, Choi G, Jung J. Smartphone addiction and depression among low-income boys since COVID-19: the moderating effect of being an only child. *Healthcare (Basel)* 2021;9(10):1350.
   PUBMED | CROSSREF

36. Chen W, Adler JL. Assessment of screen exposure in young children, 1997 to 2014. *JAMA Pediatr* 2019;173(4):391-3.
   PUBMED | CROSSREF

37. Chen CYC, Byrne E, Vélez T. Impact of the 2020 pandemic of COVID-19 on families with school-aged children in the United States: roles of income level and race. *J Fam Issues* 2021;43(3):719-40.
   CROSSREF

38. Diaz A, Baweja R, Bonatakis JK, Baweja R. Global health disparities in vulnerable populations of psychiatric patients during the COVID-19 pandemic. *World J Psychiatry* 2021;11(4):94-108.
   PUBMED | CROSSREF

39. McGuine TA, Biese KM, Petrovska L, Hetzel SJ, Reardon C, Kliethermes S, et al. Mental health, physical activity, and quality of life of US adolescent athletes during COVID-19-related school closures and sport cancellations: a study of 13000 athletes. *J Athl Train* 2021;56(1):11-9.
   PUBMED | CROSSREF

40. Newlove-Delgado T, McManus S, Sadler K, Thandi S, Vizard T, Cartwright C, et al. Child mental health in England before and during the COVID-19 lockdown. *Lancet Psychiatry* 2021;8(5):353-4.
   PUBMED | CROSSREF