



# The challenges of screen time in children with typical development and children with developmental disorders during COVID-19 pandemic

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**Background:** The significant lifestyle changes that occurred during the lockdown period associated with the COVID-19 pandemic may have had many potential adverse effects on children, in particular, sedentary screen exposure among children, including those with developmental disorders. We conducted a cross-sectional study to investigate and compare the screen time and outdoor activity time of children with typically development (TD) and those with developmental disorders during and before the emergence of COVID-19, and identified the risk factors related to screen time during the COVID-19 pandemic.

**Methods:** A total of 496 children were surveyed via online questionnaires. Parents or/and children filled in the online questionnaire, including basic characteristics, screen time, outdoor activity time, and other related factors. The Statistical Product and Service Solutions software was used to analyze all data.

**Results:** Children spent less time outdoors ( $t=14.774$ ,  $P<0.001$ ) and more time on electronic screens ( $t=-14.069$ ,  $P<0.001$ ) during the lockdown period of COVID-19, compared to the periods before COVID-19. Age ( $P=0.037$ ), pre-COVID-19 screen time ( $P=0.005$ ), screen time used for learning/education ( $P<0.001$ ), screen time of siblings ( $P=0.007$ ), and use of screen devices as electronic babysitters ( $P=0.005$ ) were risk factors for screen time during the COVID-19 pandemic, while restrictive use of electronic devices by parents ( $P<0.05$ ) was a protective factor. The screen time of children with autism spectrum disorder (ASD) or attention deficit hyperactivity disorder (ADHD) was significantly longer than children with TD before COVID-19 pandemic, but there is no statistical difference during the COVID-19 pandemic.

**Conclusions:** During the COVID-19 pandemic, children's screen exposure time increased, and outdoor activities decreased significantly. This represents a significant challenge, and we should focus our efforts on managing children's screen time and promoting healthier lifestyles, including children with typical development, as well as those with developmental disorders.

**Keywords:** Screen exposure; physical activity; autism spectrum disorder (ASD); attention deficit hyperactivity disorder (ADHD); COVID-19 pandemic

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## Introduction

The COVID-19 (coronavirus disease 2019) pandemic was a universal public health issue (1,2). By May 13, 2022 (Beijing time, GMT+8), the World Health Organization (WHO) had reported 517,648,631 confirmed cases and 6,261,708 deaths worldwide. China adopted a series of methods and public health policies to effectively control the spread of COVID-19 (3). However, due to the pandemic of the Omicron variant, confirmed cases in China continued to surge. Epidemic prevention strategies, including online teaching, limited outdoor activities, isolation, and social distancing, can bring about significant changes in lifestyles (4) which may increase children's sedentary behaviors (5). As an important aspect of sedentary behavior, there is much concern regarding changes in screen exposure among children and adolescents during the COVID-19 pandemic, and this may progress from a temporary short-term issue to a long-term permanent problem, thus affecting the development of children.

Increased electronic screen time may have many adverse effects, which may affect children more than adults (6). Especially for children before the age of 3, it may affect the overall cognitive development of children (7). The American Academy of Pediatrics (8) advises that children under

18–24 months should avoid digital media (except video chat); and children 2–5 years old should limit screen time to 1 hour per day of high-quality program, accompanied by parents. In the early days of the COVID-19 epidemic, preliminary researches (9–11) suggested that the COVID-19 pandemic would lead to changes in children's sedentary behavior, screen time, and the physical activity time, not only in China but also other countries. Furthermore, the effect of screen exposure in children with neurodevelopmental disabilities is more concerning to pediatricians than in children with typical development. Researches show (12–14) that children with autism spectrum disorder (ASD) appear to be more attracted to electronic screens, are exposed to screens longer, at a younger age, and are more prone to addiction-like symptoms than children with normally development. The anti-social aspects of screen interaction may exacerbate the symptoms of ASD (15) and may play a role in the onset of ASD (16). For children with attention deficit hyperactivity disorder (ADHD), symptoms have been shown to be positively correlated with screen time (17–19), with a higher risk of negative effects on academic performance, attention, and cognitive skills (18). Some surveys (20,21) have demonstrated that changes in children's mental health may be related to lifestyle changes during the COVID-19 pandemic.

Current studies have found that during the lockdown associated with the COVID-19 epidemic, the total media exposure time increased by 46% in ADHD children (22) and this may have aggravated the symptoms of ADHD (23), including externalizing behavior problems (24) and emotional problems (25,26). Increased screen time was also reported in children with ASD in different countries (27–29). However, there is a paucity of data concerning the electronic screen status of children with ASD/ADHD during the COVID-19 pandemic. Most of the available evidence is data from the early stages of the COVID-19 pandemic, and there is currently no relevant study focusing on the changes in children's electronic screen time after such a long lockdown of COVID-19 due to the Omicron variant. Therefore, we conducted this survey to understand the changes in children's screen time and lifestyles in the background of China's strong and long term prevention and control measures for more than two years, as well as the different characteristics of screen time changes in children with developmental disabilities and typically developing children during the epidemic. The purpose is to draw attention to the potential adverse effects of lifestyle changes on children's development during the normalized management

### Highlight box

#### Key findings

- Children spent more time on screens during the COVID-19 pandemic. The screen time of children with autism spectrum disorder (ASD) and those with attention deficit hyperactivity disorder (ADHD) was longer than that of children with typical development before the emergence of COVID-19. Risk factors for screen time included age, pre-COVID-19 screen time, screen time used for learning, screen time of siblings, use of screens as “babysitters”, and lack of parental restriction.

#### What is known and what is new?

- Children's lifestyles have changed dramatically during the COVID-19 epidemic, including those with developmental disabilities. Electronic screen exposure has adverse effects on children's development.
- This study analyzed the changes in children's screen time and lifestyles in China, and identified the risk factors of screen time in children with and without developmental disabilities.

#### What is the implication, and what should change now?

- Much effort should be directed at managing children's screen time and promoting healthier lifestyles, including children with developmental disorders.

of COVID-19, and to help teachers, parents, education departments, and health departments to gradually improve the policies and management for children and adolescents in epidemic control. We present this article in accordance with the SURGE reporting checklist (available at <https://tp.amegroups.com/article/view/10.21037/tp-23-162/rc>).

## Methods

### Participants

For this cross-sectional survey, children undergoing physical examination and children with developmental disorders attending parent training programs in the Developmental and Behavioral Department of the First Hospital of Jilin University, Changchun City, China, were enrolled. Questionnaires were distributed in the WeChat group sponsored by pediatrician of the parent training program in our department. The following inclusion criteria were applied: patients under 18 years old, who had been admitted to our department and been clearly diagnosed with developmental disorders or confirmed to have typical development by a professional pediatrician in our department; and all children with developmental disabilities participated in the parent training program and/or children rehabilitation program in our department. Participants who had not been explicitly diagnosed by our professional pediatrician or did not agree to complete the questionnaire were excluded from this study. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013) and was approved by the Ethics Committee of the First Hospital of Jilin University (No. 21K096-001).

### Procedure

Questionnaires were distributed online and informed consent was obtained from the children's parents. A study-specific questionnaire on "children/adolescents' screen use during the COVID-19 pandemic" had been pre-tested on a small scale, with parents reporting that the questionnaire was easy to understand and takes an average of 5–6 minutes to complete. Parents and/or children were required to complete the questionnaire, which included the following: child's gender, date of birth, grade level, place of residence, the average household income, the main caregiver, any siblings, marriage and education level of the parents, average outdoor activity time (on weekdays and weekends, per day), and average screen exposure time of children during and

before the COVID-19 (on weekdays and weekends, per day). An evaluator calculated the average daily outdoor activity time/screen time of the children using the following formula: Average daily outdoor activity time/screen time (hours) = [outdoor activity time/screen time per day on weekdays (hours)  $\times$ 5 + outdoor activity time/screen time per day on weekends (hours)  $\times$ 2]/7. The following questions are filled in for the last 2 months during COVID-19: types of children's outdoor activities and screen time activity, types of electronic devices, screen time for education/learning (per day on average), restrictions on screen time, the reasons for screen time restriction, parental accompaniment during screen time, screen time of caregivers and siblings (per day on average), age at first screen exposure, use of electronic screens as a tool to occupy children, use of screen time as a reward or punishment, ownership of electronic equipment, screen time before going to bed, and sleep duration. Restrictions on screen time was divide into no restriction, partial restriction (sometimes parents can consult with children) and restriction (strict restrictions without any consultation).

We analyzed the basic demographic characteristics of the 496 participates and described the demographic characteristics of ASD/ADHD children and typically development (TD) children. We also described and compared the screen time and related factors for the total cohort and for TD children, ASD children, and ADHD children during the re-emergence of COVID-19. The risk factors that influenced children' screen time during COVID-19 re-emergence were identified.

### Statistical analysis

The Statistical Product and Service Solutions (SPSS) software, version 23.0 (SPSS for Windows, SPSS Inc., Chicago, IL, USA) was used to analyze all data. Continuous variables with normal distributions are represented as mean  $\pm$  standard deviation (SD) and categorical variables are represented as frequencies (percentages). Screen time and outdoor activity time before and during COVID-19 re-emergence was compared using the paired *t*-test. The chi-square test was used to compare the rates between groups of categorical variables. Covariance analysis (covariant was "age") was used to compare groups of continuous variables. Pearson correlation was used to test the correlation between continuous variables. Comparisons of children's screen time between multiple subgroups were performed using analysis of variance (ANOVA). The significant factors in the

univariate analysis (Pearson correlation and ANOVA) were included in the multiple linear regression model to analyze the risk factors of children's screen time. A P value <0.05 was considered statistically significant.

## Results

### Basic characteristics of the participants

The basic characteristics of all participants are shown in *Table 1*. A total of 499 children were surveyed by online questionnaire, and 496 cases were available with complete data. Among them, 184 children had typical development

(TD), 128 children presented with ASD and 134 children presented with ADHD. A total of 50 children presented with other developmental disorders, including global development delay, epilepsy, intellectual disabilities, or other emotional disorders such as depression or anxiety, and these were not included in the subgroup analysis due to the small numbers in each group. For all participants, there was a significant increase in screen time ( $t=-14.069$ ,  $P<0.001$ ) and a statistically significant decrease in outdoor activity time ( $t=14.774$ ,  $P<0.001$ ) during the re-emergence of COVID-19 compared to before. All other information is detailed in *Table 2*.

**Table 1** Basic characteristics of the study participants

Variables	Total (N=496)	TD (N=184)	ASD (N=128)	ADHD (N=134)
Gender (N)				
Boy	362	110	101	112
Girl	134	74	27	22
Age (years), M (SD)	6.64 (3.23)	6.83 (3.37)	4.34 (2.12)	8.51 (2.46)
Grade level, n (%)				
Before kindergarten	95 (19.2)	15 (8.2)	71 (55.5)	0
Kindergarten	175 (35.3)	87 (47.3)	45 (35.2)	27 (20.1)
Primary	206 (41.5)	72 (39.1)	12 (9.4)	99 (73.9)
Middle school	20 (4.0)	10 (5.4)	0	8 (5.9)
Residence, n (%)				
City	448 (90.3)	172 (93.5)	115 (89.8)	115 (85.8)
Town/rural	48 (9.7)	12 (6.5)	13 (10.2)	19 (14.2)
Income/month (yuan), n (%)				
<5,000	125 (25.2)	31 (16.8)	42 (32.8)	44 (32.8)
5,000–10,000	203 (40.9)	76 (41.3)	51 (39.8)	52 (38.8)
10,000–30,000	138 (27.8)	62 (33.7)	33 (25.8)	29 (21.6)
>30,000	30 (6.0)	15 (8.2)	2 (1.6)	9 (6.7)
Caregiver, n (%)				
Parents	326 (65.7)	118 (64.1)	77 (60.2)	102 (76.1)
Parents and grandparents	142 (28.6)	57 (31.0)	42 (32.8)	25 (18.7)
Parents and nanny	4 (0.8)	1 (0.5)	1 (0.8)	1 (0.7)
Single parent	19 (3.8)	5 (2.7)	7 (5.5)	6 (4.5)
Grandparents	5 (1.0)	3 (1.6)	1 (0.8)	0

**Table 1** (continued)

**Table 1** (continued)

Variables	Total (N=496)	TD (N=184)	ASD (N=128)	ADHD (N=134)
Siblings, n (%)				
None	353 (71.2)	133 (72.3)	93 (72.7)	90 (67.2)
Older	69 (13.9)	18 (9.8)	28 (21.9)	15 (11.2)
Younger	74 (14.9)	33 (17.9)	7 (5.5)	29 (21.6)
Parents' marital status, n (%)				
Married	473 (95.4)	177 (96.2)	125 (97.7)	126 (94)
Single parent	23 (4.6)	7 (3.8)	3 (2.3)	8 (6.0)
Maternal education, n (%)				
Primary	74 (14.9)	12 (6.5)	21 (16.4)	34 (25.4)
Middle	82 (16.5)	25 (13.6)	26 (20.3)	25 (18.7)
College	248 (50.0)	81 (44.0)	70 (54.7)	65 (48.5)
Graduate	92 (18.5)	66 (35.9)	11 (8.6)	10 (7.5)
Paternal education, n (%)				
Primary	90 (18.1)	17 (9.2)	27 (21.1)	39 (29.1)
Middle	77 (15.5)	23 (12.5)	18 (14.1)	28 (20.9)
College	258 (52.0)	96 (52.2)	72 (56.3)	61 (45.5)
Graduate	71 (14.3)	48 (26.1)	11 (8.6)	6 (4.5)

Data are expressed as n (%) or M (SD). TD, typically developed; ASD, autism spectrum disorder; ADHD, attention deficit hyperactivity disorder; M, mean; SD, standard deviation.

**Table 2** Investigation on children's electronic screen use and related factors

Factors	Total	TD	ASD	TD vs. ASD		ADHD	TD vs. ADHD	
				F/ $\chi^2$ /Z	P		F/ $\chi^2$ /Z	P
Screen time before epidemic (hours/d)	0.94 (1.12)	0.79 (0.76)	1.00 (1.48)	7.00	0.009	1.01 (1.13)	4.762	0.030
Screen time during epidemic (hours/d)	2.01 (1.89)	2.00 (1.97)	1.45 (1.65)	1.945	0.164	2.58 (1.82)	0.150	0.699
t	-14.069	-9.248	-4.485			-9.465		
P	<0.001	<0.001	<0.001			<0.001		
Outdoor activity time before epidemic (hours/d)	0.78 (0.57)	0.84 (0.58)	0.81 (0.59)	0.353	0.553	0.73 (0.53)	Z=-1.518	0.129
Outdoor activity time during epidemic (hours/d)	0.38 (0.35)	0.36 (0.31)	0.40 (0.43)	1.099	0.295	0.39 (0.32)	Z=-1.104	0.270
t	14.774	10.773	7.139			7.381		
P	<0.001	<0.001	<0.001			<0.001		
Screen time for education/learning (hours/d)	1.08 (1.33)	1.06 (1.32)	0.40 (0.71)	0.060	0.807	1.70 (1.45)	1.465	0.227
Screen time restriction, n (%)								
No restriction	9 (1.8)	4 (2.2)	3 (2.3)	4.959	0.084	1 (0.7)	1.026	0.599
Partial restriction	286 (57.7)	113 (61.4)	63 (49.2)			83 (61.9)		
Restriction	201 (40.5)	67 (36.4)	62 (48.4)			50 (37.3)		

**Table 2** (continued)

Table 2 (continued)

Factors	Total	TD	ASD	TD vs. ASD		ADHD	TD vs. ADHD	
				F/ $\chi^2$ /Z	P		F/ $\chi^2$ /Z	P
The companionship during screen time, n (%)								
Accompanying with communication	203 (40.9)	80 (43.5)	62 (48.4)	2.941	0.230	44 (32.8)	3.700	0.157
Accompanying without communication	87 (17.5)	33 (17.9)	14 (10.9)			28 (20.9)		
No accompanying adult	206 (41.5)	71 (38.6)	52 (40.6)			62 (46.3)		
Screen time of parents (hours/d)	2.86 (2.08)	3.01 (2.16)	2.41 (1.97)	0.796	0.373	3.10 (2.02)	0.051	0.821
Screen time of siblings (hours/d)	1.76 (2.14)	1.52 (1.89)	2.52 (2.59)	Z=-1.55	0.120	1.56 (2.09)	Z=-0.240	0.810
Age of first screen exposure, n (%)								
0-0.5 years	20 (4.0)	9 (4.9)	9 (7.0)	31.840	<0.001	2 (1.5)	8.046	0.090
0.5-1 year	87 (17.5)	25 (13.6)	42 (32.8)			12 (9.0)		
1-2 years	150 (30.2)	55 (29.9)	47 (36.7)			32 (23.9)		
2-3 years	107 (21.5)	37 (20.1)	17 (13.3)			38 (28.4)		
Over 3 years	132 (26.6)	58 (31.5)	13 (10.2)			50 (37.3)		
Frequency of screen exposure before bedtime, n (%)								
No exposure	297 (59.9)	120 (65.2)	76 (59.4)	1.428	0.699	70 (52.2)	7.198	0.066
1-3 d/week	92 (18.5)	30 (16.3)	26 (20.3)			23 (17.2)		
3-5 d/week	35 (7.1)	11 (6.0)	7 (5.5)			15 (11.2)		
5-7 d/week	72 (14.5)	23 (12.5)	19 (14.8)			26 (19.4)		
Screen time before sleep (hours/d)	0.29 (0.76)	0.28 (0.76)	0.19 (0.42)	0.010	0.922	0.39 (0.88)	0.421	0.517
Sleep duration (hours)	8.93 (1.13)	8.94 (1.03)	9.10 (1.36)	0.001	0.995	8.81 (1.01)	<0.001	0.999
Electronic nanny, n (%)								
Almost never	193 (38.9)	69 (37.5)	42 (32.8)	5.102	0.078	59 (44.0)	2.874	0.238
Sometimes	265 (53.4)	106 (57.6)	71 (55.5)			65 (48.5)		
Always	38 (7.7)	9 (4.9)	15 (11.7)			10 (7.5)		
As a reward or punishment, n (%)								
Almost never	209 (42.1)	77 (41.8)	64 (50.0)	2.070	0.355	42 (31.3)	6.616	0.037
Sometimes	254 (51.2)	98 (53.3)	58 (45.3)			77 (57.5)		
Always	33 (6.7)	9 (4.9)	6 (4.7)			15 (11.2)		
Ownership of independent electronic equipment, n (%)								
No	309 (62.3)	113 (61.4)	101 (78.9)	10.722	0.001	67 (50.0)	4.112	0.043
Yes	187 (37.7)	71 (38.6)	27 (21.1)			67 (50.0)		

Data are expressed as n (%) or M (SD). TD, typically developed; ASD, autism spectrum disorder; ADHD, attention deficit hyperactivity disorder; M, mean; SD, standard deviation.

### ***Risk factors for electronic screen time in children during the COVID-19 epidemic***

The correlation analysis of screen time and related factors is shown in Table 3. The children were divided into multiple

subgroups according to grade levels, parental education, ownership of independent electronic devices, degree of screen restriction, frequency of parental guidance during screen use, frequency of screen use as a form of babysitting,

**Table 3** Correlation between screen time and factors during the COVID-19 epidemic

Factors	Age	Screen time before COVID-19	Outdoor activity time	Screen time for learning/education	Screen time of parents	Screen time of siblings	Age of first exposure to screen
R	0.519	0.224	-0.033	0.587	0.416	0.313	0.192
P	<0.001	<0.001	0.467	<0.001	<0.001	<0.001	<0.001

COVID-19, coronavirus disease 2019.

Grade levels	Before kindergarten	Kindergarten	Primary	Middle school	F	P
Screen time (mean ± SD) (hours/d)	1.07±1.53	1.50±1.39	2.54±1.84	5.45±2.25	51.257	<0.001
Maternal education	Primary	Middle	College	Graduate	F	P
Screen time (mean ± SD) (hours/d)	1.95±1.99	1.80±1.66	2.13±2.00	1.93±1.68	0.748	0.524
Paternal education	Primary	Middle	College	Graduate	F	P
Screen time (mean ± SD) (hours/d)	2.16±2.07	2.03±1.84	1.86±1.84	2.36±1.88	1.549	0.021
Independent electronic devices	No		Yes		F	P
Screen time (mean ± SD) (hours/d)	1.54±1.56		2.80±2.12		31.25	<0.001
Degree of restriction	No restriction	Partial restriction	Restriction	F	P	
Screen time (mean ± SD) (hours/d)	3.63±2.69	2.51±1.93	1.23±1.89	34.411	<0.001	
Frequency of accompanying	Accompanying with communication	Accompanying without communication	No accompanying	F	P	
Screen time (mean ± SD) (hours/d)	1.31±1.41	2.34±1.92	2.57±2.07	26.60	<0.001	
Frequency of electronic nanny	Almost never	Sometimes	Always	F	P	
Screen time (mean ± SD) (hours/d)	1.67±1.80	2.05±1.82	3.51±2.41	16.018	<0.001	
Frequency of punishment/reward	Almost never	Sometimes	Always	F	P	
Screen time (mean ± SD) (hours/d)	1.60±1.75	2.29±1.95	2.49±1.81	8.926	<0.001	

**Figure 1** Differences in screen time among groups during the COVID-19 pandemic (grouping by grade levels, maternal education, parental education levels, independent electronic devices, degree of restriction, frequency of accompanying, frequency of electronic nanny, and frequency of punishment/reward). SD, standard deviation; COVID-19, coronavirus disease 2019.

and frequency of screen use as a punishment or reward. The screen use of each subgroup is shown in *Figure 1*. The significant factors of univariate analysis were incorporated into the multiple linear regression model, and the rank data were transformed into dummy variables (the assignment of dummy variables is presented in *Table 4*). Regression analysis suggested that risk factors for children’s screen time during COVID-19 are age, degree of restriction, screen time before COVID-19, screen time for learning/education, screen time of siblings, and frequent use of electronic devices as a form of babysitting (see details in *Table 4*).

**Screen time in children with TD, ASD, and ADHD**

We separately described the above content for TD children, ASD children, and ADHD children among all participants, and compared ASD children and ADHD children with TD children, respectively. The differences in the average daily screen use before and during COVID-19 re-emergence were statistically significant in TD children, ASD children, and ADHD children (*Table 2*). Before COVID-19, ASD children (F=7.00, P=0.009) and ADHD children (F=4.762, P=0.030) had longer screen time use compared to TD

**Table 4** Risk factors for electronic screen time in children during the COVID-19 epidemic (results of multiple linear regression)

Factors	$\beta$	t	P	95% CI
Age	0.248	2.110	0.037	0.009, 0.285
Screen time before COVID-19	0.191	2.889	0.005	0.084, 0.451
Independent electronic devices (no =0, yes =1)	0.067	1.098	0.274	-0.211, 0.738
Screen time for learning/education	0.462	5.665	<0.001	0.420, 0.871
Screen time of parents	0.081	1.179	0.240	-0.049, 0.195
Screen time of siblings	0.181	2.728	0.007	0.045, 0.283
Age of first exposure to screen	-0.061	-0.938	0.350	-0.361, 0.129
Grade levels (before kindergarten =0)				
Kindergarten =1 (dummy variable)	0.020	0.221	0.826	-0.659, 0.824
Primary school =1 (dummy variable)	-0.153	-1.165	0.246	-1.613, 0.417
Middle school =1 (dummy variable)	0.001	0.006	0.995	-1.181, 1.822
Degree of restriction (no restriction =0)				
Partial restriction =1 (dummy variable)	-0.600	-2.429	0.017	-4.488, -0.459
Restriction =1 (dummy variable)	-0.688	-2.675	0.008	-4.989, -0.747
Frequency of accompanying (no =0)				
Without communication =1 (dummy variable)	-0.059	-0.924	0.357	-0.845, 0.307
With communication =1 (dummy variable)	0.022	0.339	0.735	-0.449, 0.634
Frequency of electronic nanny (almost never =0)				
Sometimes =1 (dummy variable)	0.131	1.833	0.069	-0.041, 1.077
Always =1 (dummy variable)	0.200	2.859	0.005	0.389, 2.137
Frequency of punishment/ reward (almost never =0)				
Sometimes =1 (dummy variable)	-0.033	-0.477	0.634	-0.650, 0.397
Always =1 (dummy variable)	-0.036	-0.561	0.576	-1.206, 0.673

COVID-19, coronavirus disease 2019; CI, confidence interval.

children, after controlling for age with statistical methods. However, no statistically significant differences were found during COVID-19 between the groups. The average duration of daily outdoor activity before and during COVID-19 were significantly different for TD children, ASD children, and ADHD children (*Table 2*). Compared with TD children, however, there was no statistically significant difference in outdoor activity time between TD children and ASD/ADHD children before COVID-19 nor during the COVID-19 pandemic.

Compared with TD children, children with ASD had a younger age of first screen exposure ( $\chi^2=31.84$ ,  $P<0.001$ ), and parents of ADHD children were more likely to use screens as a reward or punishment ( $\chi^2=6.616$ ,  $P=0.037$ ). During the COVID-19 pandemic, there was no statistical difference between TD children and ASD/ADHD children in terms of screen time for education/learning, screen time restriction, the companionship during screen time, screen time of parents, screen time of siblings, screen time before sleep, sleep duration, nor the frequency that screens were



used as babysitters (Table 2).

## Discussion

### *During the COVID-19 pandemic, time spent outdoors decreased and screen time increased*

This study demonstrated that children spent less time outdoors and more time on electronic screens during the COVID-19 pandemic. The changes were seen in all children, whether in TD children, or ASD/ADHD children. Although the outbreak has been recurring for more than 2 years and China has experienced a very long period of regular prevention and control measure, our results are consistent with the earlier studies on COVID-19 and are not specific to China. A meta-analysis (30) showed that sedentary behavior in children was most affected by the COVID-19 pandemic (compared to adults and the elderly), with an increase in sedentary time of  $159.5 \pm 142.6$  min/day. A study of children aged 3–16 years in Spain (31) showed that preschoolers (ages 3 to 4) increased their screen exposure by 2.2 hours per day. An online survey at the beginning of COVID-19 in the United States reported that 211 parents of children aged 5–13 years perceived that children's physical activity time had decreased, whereas children's sedentary behavior had increased (32). Of all the sedentary behavior, children spent the most time watching television, videos, and movies. A total of 94% of parents interviewed reported that during the COVID-19 pandemic, children's physical activity had decreased and 81% parents reported that children's screen time had increased (33). Only about 3% of children met the recommended guidelines of 60 minutes of moderate-intensity physical activity per day during the COVID-19 pandemic (34). The situation is not exactly the same in different countries. In Sweden (35), physical activity, outdoor time, and screen time increased significantly among preschoolers, and this is attributed to the fact that Sweden did not close outdoor venues during this period. The change in outdoor hours may relate to national policy.

Governments, schools, health workers, sport professionals, and parents need to be aware of the grim situation and implement more effective interventions immediately to minimize the negative impact of the COVID-19 pandemic on the health of children and adolescents (36). It is recommended that governments develop policies to promote healthy lifestyles and screen use (33,37).

### *Risk factors of children/adolescents' screen time use during the COVID-19 pandemic*

Our study suggested that during the COVID-19 pandemic, prolonged screen time use by children/adolescents was associated with older age, longer pre-COVID-19 screen time, longer screen time used for learning/education, longer screen time of siblings, decreased parental restrictions on screen time, and the frequency with which parents used screen devices as babysitters.

Early in the pandemic, a study was conducted in Turkey (38) on the relationship between parenting practices and screen time in children during the COVID-19 pandemic. Results showed that age, household income, mother's employment status, family's rules about screen time, and inconsistent parenting practices were defined as significant predictors in children's screen time. This is partly consistent with our results, which also found that age and family rules (the restrictions imposed by parents, and the frequency of using screen devices as babysitters) were associated with children's screen time. Many studies have also confirmed that the establishment of family screen rules can limit children's screen time (39,40), but the existence of rules not sufficient if there is inconsistent application of the rules (38), or if parents use electronic screens to occupy the children (41).

Some studies (42,43) have found that children whose parents have more screen time also have more screen time, but our results suggested that electronic screen time of siblings is more likely to influence children's electronic screen time. Durham (44) reported a significant relationship between the presence of a sibling and children's screen time. This situation may be more obvious during the COVID-19 pandemic. Siblings tend to demand extra screen time to achieve what they perceive as "fairness". This may directly expose child to additional screen time, if it is in the form of television or on a large screen. The study did not investigate age of siblings. This may be a limitation of our study. Differences in screen activity may be due to differences in sibling age, which may have different effects on participants' screen time. In addition, we did not analyze differences in screen time between children with and without siblings to see if the absence of siblings might be a protective factor for screen time. Our study also suggested that age and screen time used for learning/education are also risk factors for children's screen time during the COVID-19 epidemic. This appears to be a unique situation during the pandemic

when children needed to use electronic devices increasingly with age and grade to participate in online lessons, complete homework, complete group activities, interact with teachers, and other activities through mediums such as Zoom or Tencent Meeting (45). Although these online resources were convenient and satisfied a need during the pandemic (46), we cannot ignore the adverse effects on children and adolescents. Another interesting issue is that numerous studies have found that less time spent in physical activity is a risk factor for more screen time in children (47-49), but our study did not suggest this. Implementation of COVID-19 pandemic policies has limited outdoor activity time for all children. We hypothesize that other non-sedentary behaviors such as housework at home, strength training at home, and physical activity at home may still influence children's screen time. However, this report did not investigate children's indoor physical activity, which is a limitation of this study.

#### *A comparison of screen time in children with TD, ASD, and ADHD*

The results herein suggested that both ASD and ADHD children had longer screen time use than TD children before the pandemic of COVID-19, however, there was no statistical difference during the COVID-19 pandemic.

Many studies (14,50,51) have found that children with ASD had higher screen time even when there is no COVID-19 epidemic, and this is not a novel topic. Cardy's study (28) reported that, compared to the community sample, the ASD group had a significantly higher screen time use before and during the COVID-19 pandemic school closures. Our study did not find that children with ASD had more screen time during the pandemic than children with TD, but found that TD children had more screen time on average (2 hours) than children with ASDs (1.45 hours), although this was not statistically significant. However, the average age of the ASD children in this study was over 11 years old, while the ASD children we included were younger with an average age of 4.34 years old, and more than 90% of the ASD children did not attend primary school. Another important point to note is that these parents have received systematic parent training programs (52) in our department and have a certain understanding of screen exposure and children's development. Parent training programs focus on the education of parents, family support, family interaction and play programs, with an emphasis on

the ecological environment of early childhood development in ASD children. It should be added that the statistical effect may be affected by the large age gap in the sample, because the ASD group is too young to be likely to have screen time of learning. ASD children are more likely to prefer stereotypical screen content that appeals to them, rather than learning content. And the screen time of the typical children may have been academic. These may have contributed to some extent to our results, which need to be confirmed by further research.

Longer screen time in children with ADHD has also been reported (17,53), and screen time for ADHD has increased significantly during COVID-19 (54). These are all consistent with our research. However, we found no statistical difference in screen time between ADHD children and TD children during the COVID-19 epidemic. Since ADHD children suffer from an executive function deficit (55), they are less able to control their own behavior than children of the same age. During the pandemic, children had more autonomous time, and children with less self-control were more likely to choose screen activities that appealed to children. From this point of view, our results which found no difference in screen time between children with ADHD and those with TD seemed difficult to explain. However, similar to the ASD children, the parents of the enrolled ADHD children had undergone a parent training program. This suggested a possible role of parent training programs in the management of children's electronic screen time, which may be examined further in our future work.

#### *Limitation*

This was a cross-sectional study, and future studies are expected to establish cohorts to explore the development of children growing up with the COVID-19 virus. In the procedure of data collection, parent surveys are limited by recall bias, especially for the earlier data. Therefore, future research tends to choose more accurate methods. Children with developmental disabilities included in our study had parents who participated in our training program, and thus, there is a large sampling bias among the children participating in the survey. The majority of ASD children in this cohort were preschoolers, while the majority of ADHD children were school-age children. This may have significantly impacted some of the comparisons, especially since screen time seems to be associated with age. Further research should be conducted using comparable ages and a

larger sample size to verify these results.

## Conclusions

This is the first study to compare the screen time of children with TD and children with developmental disabilities during and before COVID-19 pandemic. There are great challenges surrounding the use of screens by children during the COVID-19 pandemic. Children's screen time increased and outdoor activities decreased significantly. Age, pre-COVID-19 screen time, screen time used for learning/education, screen time of siblings, and parental use of screen devices as babysitters were identified as risk factors for screen time during COVID-19, while parental restrictions on screen use was a protective factor. The screen time of ASD and ADHD children was significantly longer than TD children before COVID-19 pandemic. It is imperative that we focus on managing children's screen time and promoting healthier lifestyles, including children with typical development and those with developmental disorders.

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## Footnote

*Reporting Checklist:* The authors have completed the SURGE reporting checklist. Available at <https://tp.amegroups.com/article/view/10.21037/tp-23-162/rc>

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*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Ethics Committee of the First Hospital of Jilin University (No. 21K096-001) and informed consent was taken from all the children's parents throughout the internet.

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