



Preschool children's screen time during the COVID-19 pandemic: associations with family characteristics and children's anxiety/withdrawal and approaches to learning

Xiangzi Ouyang¹ · Xiao Zhang¹ · Qisi Zhang² · Xin Gong³ · Ronghua Zhang⁴

Accepted: 17 May 2023 / Published online: 31 May 2023

© The Author(s), under exclusive licence to Springer Science+Business Media, LLC, part of Springer Nature 2023

Abstract

With schools closed due to the COVID-19, many children have been exposed to media devices for learning and entertainment, raising concerns over excessive screen time for young children. The current study examined how preschoolers' screen time was associated with their family characteristics and anxiety/withdrawal and approaches to learning during the COVID-19 pandemic. Participants were 764 caregivers of 3- to 6-year-old children (mean age = 59.07 months, SD = 12.28 months; 403 boys and 361 girls) from nine preschools in Wuhan, China, where the pandemic started. The effects of family characteristics on children's screen time during the pandemic outbreak and the associations between screen time and children's anxiety/withdrawal and approaches to learning were examined using path analysis. The results showed that children who spent more time on interactive screen use (e.g., playing with tablets) showed higher levels of anxiety/withdrawal and fewer positive learning behaviors. Unexpectedly, children who spent more time on noninteractive screen use (e.g., watching TV) showed lower levels of anxiety/withdrawal. Additionally, children's screen time was related to family characteristics: children living in more chaotic families with fewer screen time restrictions spent more time on screen use after the pandemic outbreak. The findings suggest that young children's frequent use of interactive screens, such as tablets and smartphones, might be harmful to their learning and wellbeing during the pandemic. To mitigate the potential negative effects, it is essential to manage the screen time of preschoolers by establishing rules for their interactive screen use and improving the household routines related to the overall screen use.

Keywords Screen time · Young children · Anxiety and withdrawal · Approaches to learning · COVID-19

Introduction

The COVID-19 pandemic has affected individuals' health, social life, and well-being. As a result of the pandemic, stores are shutting down, health care resources are under great strain, and schools are closing (Rundle et al., 2020).

This has created serious problems for families with young children. According to the World Health Organization (WHO) guideline (2019), the screen time of children under 5 years old should be no more than 1 h a day. During the pandemic, however, children's screen time is likely to increase and exceed this criterion (Susilowati et al., 2021). Moreover, children's preschool years are a stage of development when the brain undergoes rapid development (Knudsen, 2004), and thus it is important to understand the impact of excessive screen time on preschool-aged children's emotional problems and learning behaviors. The present study aimed to examine preschoolers' screen time and changes in their screen time in relation to their learning behaviors, anxiety/withdrawal and familial correlates during the pandemic outbreak in Wuhan, China, where the pandemic originated.

✉ Xiao Zhang
xzhang1@hku.hk

¹ Faculty of Education, The University of Hong Kong, Pokfulam Road, Hong Kong, China

² English Department, Purdue University, West Lafayette, USA

³ Faculty of Education, Central China Normal University, Wuhan, China

⁴ Institute of Developmental and Educational Psychology, Wuhan University, Wuhan, China

Theoretical framework

According to the Differential Susceptibility to Media Effects Model (Valkenburg & Peter, 2013), excessive screen time may negatively affect a wide range of children's developmental outcomes. These outcomes include health conditions (e.g., motor skills development, obesity problems, unhealthy diets, and sleep problems; Marinelli et al., 2014; Pagani et al., 2013; Torsheim et al., 2010), cognitive development (e.g., poor number and vocabulary knowledge; Pagani et al., 2013), and socioemotional development (e.g., external problem behavior, such as aggression; Chonchaiya et al., 2015; Duch et al., 2013). For example, Pagani et al.'s (2013) longitudinal study showed that children's TV viewing time was negatively associated with their gross motor skills, vocabulary, and number skills as well as classroom engagement in children aged 29 to 65 months. Moreover, excessive screen use has also been shown to relate to children's social-emotional maladjustment, such as external problem behavior (Watt et al., 2015), poor self-regulation (Radesky et al., 2014), and high levels of anxiety (Mistry et al., 2007). Due to the sharp change in children's daily life after the pandemic outbreak, children's anxiety is likely to increase (Wang et al., 2020). It is important to examine whether children's screen use alleviates or increases their level of anxiety during the pandemic. Moreover, due to the pandemic and resulting school closures, electronic devices, such as tablets, may serve as important learning tools at home (Trott et al., 2022). Under this circumstance, children may have less chance to communicate with their teachers and peers, which could jeopardize children's positive approaches to learning (i.e., positive disposition toward learning, persistence, motivation, and frustration tolerance during learning activities; Kagan et al., 1995; Suarsi & Wibawa, 2021). Therefore, this study also focuses on the influences of children's screen time on children's anxiety/withdrawal and approaches to learning.

Given the deleterious outcomes of excessive screen use for preschool children, it is worthwhile to identify the risk factors of children's screen time during the pandemic. The media effects model (Valkenburg & Peter, 2013) proposed that three types of factors serving as the predictors of screen time, namely dispositional factors (e.g., personal variables, such as sex), developmental factors (e.g., age) and social factors (e.g., family, schools, culture). In early childhood, parents play a significant role in shaping their children's behaviors through serving as role models and interacting with their children (Rhee, 2008). This is especially true during the COVID pandemic, when schools were closed, and children spent more time with their parents when staying at home (Koh et al., 2020). It is important to examine whether

and how family factors are related to young children's screen time during the pandemic.

Screen time and children's anxiety and withdrawal

Screen use can be categorized as noninteractive and interactive screen use: the former refers to the use of media that provide no or little interaction for the users, such as televisions or videos (Pagani et al., 2013), while the latter refers to the use of media that involve interactions, such as computers, tablets, and smartphones (Chassiakos et al., 2016). Studies have documented that children's screen time was negatively correlated with mental health outcomes, such as levels of anxiety and withdrawal (e.g., Mistry et al., 2007; Zimmerman et al., 2005). For instance, students' excessive screen time (i.e., more than 2 h per day) has been found to be related to their self-reported high levels of anxiety (Taheri et al., 2019). Similarly, Chinese children's screen time has also been shown to associate with high risk of emotional problems before (Song et al., 2020; Zhao et al., 2018) and after the COVID-19 pandemic outbreak (Yue et al., 2022). However, these studies did not distinguish between noninteractive and interactive screen time, which have been found to differ in their effects on children's levels of anxiety or withdrawal (Page et al., 2010).

Noninteractive screen time has been found to be positively associated with children's anxiety (Mistry et al., 2007; Kremer et al., 2014; Singer et al., 1998). Mistry et al. (2007) documented that preschool children's anxiety was related to their TV use, and heavy exposure to TV from early childhood was associated with more severe symptoms. Other studies have supported these relations after taking into account control variables (e.g., Allen & Vella, 2015). For example, Hamer et al. (2009) controlled for physical activity levels, child's age, sex, single-parent status, medical conditions, and other dietary intake variables in their study of 1,486 children and identified a positive relation between TV viewing time and psychological distress.

Unlike the findings on noninteractive screen time, the findings on the relation between interactive screen time and children's levels of anxiety and withdrawal have been mixed. Some studies have documented a positive correlation between children's interactive screen time and their levels of anxiety and withdrawal (Przybylski, 2014; Vernon et al., 2018; Woods & Scott, 2016). Page et al. (2010) found that children who spent more than two hours a day in computer use were more likely to have psychological difficulties. However, studies have also indicated that interactive screen time benefits children's mental health. An experimental study found that some well-designed apps successfully improved children's social-emotional ability, such as the ability to control anger (Radesky, 2018). The findings

are also mixed in Chinese context. Liu et al. (2021) showed that interactive screen time was associated with 4-year-old children's emotional problems. However, Hu et al. (2018) indicated that interactive screen time did not correlate with Chinese preschool children's emotional problems. More studies are needed to investigate whether and how children's interactive screen time is associated with their anxiety and withdrawal, especially during the pandemic, when they are vulnerable to emotional problems due to the drastic change in their daily life (Yue et al., 2022).

Screen time and approaches to learning

The approach to learning, also known as adaptive learning behavior, is an important indicator of children's school readiness and future learning outcomes (Fantuzzo et al., 2004). Due to school closure during the COVID pandemic, children are likely to spend more time on screen use for entertainment and learning at home (Trott et al., 2022). Examining whether screen time during the pandemic affects children's approaches to learning may provide a basis for practitioners to decide whether they should use screens as a learning tool at home when face-to-face learning is unavailable. Previous studies have shown noninteractive screen time to be negatively associated with children's approaches to learning (Pagani et al., 2013; Johnson et al., 2007; Patimah & Kiswaya, 2019). For instance, Gupta et al. (1994) found that children who watched TV for an average of 18.5 h a week showed decreased interest to learn.

Interactive screen time has been shown to have similar negative effects. Tamana et al. (2019) demonstrated that interactive screen time was related to preschoolers' inattention problems: children who spent more than two hours a day in media devices were 7.7 times more likely to be diagnosed with ADHD. Recent studies conducted during the COVID pandemic outbreak found that children's interactive screen time, such as online learning and video games, had a negative impact on their learning interest and motivation (Rahayu et al., 2021; Suarsi & Wibawa, 2021). However, these studies focused on Euro-American children of primary school age, and the question of whether screen time affects Chinese preschool children's approaches to learning during the pandemic received less attention. Tan and Zhou's (2022) study, conducted in Chinese children, indicated that preschool children's (aged 3 to 6) excessive screen time predicted children's inattention problem, but they did not distinguish between the different types of screen time.

Familial correlates of children's screen time

In the current COVID-19 situation, preschool children are spending a great deal of time with their primary caregivers

and are encouraged to maintain social distance to avoid the spread of the virus (Koh et al., 2020). This strongly suggests that more attention needs to be paid to the influences of family factors on children's screen use. Investigating the family factors associated with screen time can help us identify children who are at risk of excessive screen use during the pandemic and provide insights on how caregivers may manage children's screen time at home. Among various family factors, home environment has been found to strongly relate to how children spend their time at home (Rhodes et al., 2019). Disruptions to daily routines within home environments, namely household chaos, are an important risk factor for children's excessive screen use (Emond et al., 2018). Additionally, caregivers are in the best position to prevent children from engaging in excessive and uncontrolled screen use during the pandemic. Caregivers' restrictions on children's screen time have been documented to be one of the most effective ways to reduce children's screen time (Salmon et al., 2005). Therefore, this study focused on caregivers' restrictions on screen time and household chaos as proxies for family characteristics that influence preschoolers' screen time during the pandemic.

Caregivers' restrictions on screen time in relation to children's screen use

Rules or restrictions have been found to affect children's screen time (Salmon et al., 2005; Van den Bulck & Van den Bergh, 2000). Restrictions on screen time refers to caregiver-child communication aimed at restricting child's screen time (Lin & Atkin, 1989). Findings on the effects of restrictions on children's screen time have been inconsistent in prior studies depending on the type of medium: noninteractive or interactive screen use (Collier et al., 2016). A review of parental restrictions on noninteractive screen time concluded that most studies found that parental restrictions on TV time led to decreases in children's TV viewing (Xu et al., 2015). Relatedly, a study of young children aged six months to six years also indicated an association between parental rules concerning TV use and less time spent by children watching TV (Vandewater et al., 2005). Studies on Chinese children also indicated that children were more likely to spend over 2 h a day on TV viewing when there were no rules on screen use at home (Jiang et al., 2014). As for interactive screen time, Downing et al. (2015) found a significant correlation between caregivers' rules on screen time and preschool children's interactive screen time. Additionally, Wang et al.'s (2022) study, conducted in 1546 Chinese preschoolers, showed that clear rules on interactive screen use helped reduce preschool children's interactive screen time. However, these studies were conducted before the COVID pandemic outbreak, and more studies are

needed to investigate whether restrictions on screen time is an effective method to reduce children's screen time during the pandemic.

Household chaos in relation to children's screen use

Household chaos is another risk factor of children's screen use, especially during the pandemic. Due to the high contagious nature of COVID-19, social distancing and quarantine policy have led to more families residing at home for longer periods of time. Consequently, household chaos, characterized by increased levels of noise, crowding, and a lack of order and routine in households, is likely to increase (Cassinat et al., 2021). Levels of household chaos are related to young children's behaviors, including screen use (Emond et al., 2018; Kracht et al., 2021; Martin et al., 2012). For instance, Emond et al. (2018) studied 385 parents of 2-5-year-old children and indicated that greater household chaos was correlated with increases in children's screen time. To be more specific, higher levels of household chaos predicted an increase in the amount of children's weekly screen use, especially the time children spent watching shows, videos, and movies, although it was not correlated with interactive screen time. Furthermore, a recent study, involving a sample of 1836 families with preschoolers in the United States, showed that children living in families with higher levels of household chaos had more screen time during the pandemic (Kracht et al., 2021). However, the relation between household chaos and preschoolers' screen time in Chinese children during the pandemic remains unclear.

The present study

China, where the COVID-19 pandemic outbreak starts, experienced stringent and longtime home quarantine (Zhang, 2022). Under the circumstance, in person classes were canceled and children were encouraged to engage in online learning during the pandemic (Ministry of Education of China, 2020). Although not required to offer online teaching, many preschools encouraged parents to use digital resources and tablets to support preschoolers' learning and entertainment at home (Dong et al., 2020). Such sudden and sharp increases in Chinese children's screen time have led to worries about possible negative consequences (Xiang et al., 2020). The existing studies showed that screen time affected children's approaches to learning and anxiety/withdrawal, but these studies focused primarily on Euro-American children and most of them were conducted before the pandemic outbreak (e.g., Taheri et al., 2019). Furthermore, studies of the risk factors of screen time during the pandemic in Chinese children remain scarce. Examining the family factors of screen time can help us know which children may

be more vulnerable to excessive screen time than others and give insights on how to reduce children's screen time during the pandemic. Therefore, this study, drawing on the media effects model (Valkenburg & Peter, 2013), aimed to simultaneously examine the consequences and family factors of Chinese preschool children's screen time during the pandemic.

In this study, screen time and changes in screen time after the pandemic outbreak were examined as a proxy of screen use during the pandemic. Screen time represents the absolute amount of time spent on media use, such as TV (Sweetser et al., 2012), while changes in screen time represent the relative variations of screen time, which are also important to study during the pandemic because they may reflect, to some extent, how children and caregivers cope with the COVID-19 restrictions. The two variables are different but correlated, because children who increase their screen time tend to have long screen time during the pandemic. Studies have found that children's screen time generally increased more than twice after the pandemic outbreak (Aguilar-Farias et al., 2020), and such increases might have led to a decrease in, for instance, physical activities and sleep time.

In response to the calls from the American Academy of Pediatrics (AAP) for more attention on the types of screen time, we aimed addressed the following research questions in this study:

RQ1 Do Chinese children's screen time and changes in their screen time (noninteractive and interactive screen time) relate to their levels of anxiety/withdrawal and approaches to learning?

RQ2 Are household chaos and caregivers' restrictions on screen time correlated with Chinese children's screen time and changes in screen time?

Based on the literature review, the following hypotheses were generated: H1: noninteractive time and interactive screen time and their increases during the pandemic would be positively associated with children's high levels of anxiety/withdrawal. H2: Children's noninteractive screen time and interactive screen time and their increases would be negatively correlated with children's approaches to learning. H3: Children from more chaotic families and with fewer restrictions on their screen time would spend more time on and showed larger increases in noninteractive and interactive screen use during the pandemic.

Method

Participants and procedure

This study used a cross-sectional design. A retrospective method was adopted to assess children's change in screen time before and after the pandemic outbreak. We recruited 764 caregivers of young children (403 boys [52.7%] and 361 girls [47.3%]) from nine preschools located in Wuhan, China using the typical case sampling. To maximize the response rate, our sampling covered all 3–6-year-olds children in the preschools. The mean age of the children was 59.07 months ($SD=12.28$ months). Most of the caregivers were children's parents ($n=716$, 93.7%), 29 caregivers (3.8%) were other relatives, such as grandparents, and 19 caregivers did not indicate their relationship with the children (2.5%). Table 1 shows the sex and age of the children and their family SES.

We collected data from mid-June to mid-July in the year 2020, when Wuhan had been reopened after a 76-day lockdown, but schools remained closed because of the pandemic. At first, we obtained the consent of the principals of the nine preschools and distributed 1200 questionnaires to the caregivers of the children from those schools. The primary caregivers of the children from seven preschools completed the consent forms and questionnaires at home, while those from the other two preschools completed the consent forms and questionnaires at school. A total of 790 caregivers provided written consent and finished the questionnaires (participation rate: 63.7%). Of these, 764 questionnaires were valid. The present study was permitted by the Institutional Review Board of the first author's university. This study was not preregistered.

Measures

Screen time

Children's screen time was reported by the caregivers. We adopted the measure from a previous study in the context of China which showed a good reliability ($\alpha=0.80$; Hu et al., 2018). The measure consisted of three items about the amount of time spent on TV or videos, computers or tablets, and smartphones, respectively. A sample question is, "How long on average did the child spend on watching TV or videos per day in the previous month?" (4 = *More than two hours*, 3 = *One hour to two hours*, 2 = *Half an hour to one hour*, 1 = *Less than half an hour*, 0 = *Never*).

The first item measured noninteractive screen time; the mean scores of the last two items were used to represent interactive screen time; and finally, the mean scores of the three items were calculated to represent total screen time. We asked about the time children spent on watching videos in the first item and used the wording "play" when asking about the time spent on interactive screen time. Therefore, we expected the caregivers would report the time their child spent on watching videos (even in tablets or computers) in Item 1. The Cronbach's alpha of the measure was 0.57. The correlations between the three items were moderate (r ranges from 0.28 to 0.35, $ps < 0.01$). The relatively low reliability of the measure is possibly due to that the children spent more time on noninteractive screen use (76.6% of the children spent more than half an hour on TV viewing) than interactive screen use (40.5% and 37.2% of the children spent more than half an hour playing computers and cell-phones, respectively).

Table 1 Descriptive Statistics

Variables	<i>N</i>	Minimum	Maximum	<i>M</i>	<i>SD</i>	<i>Median</i>
Child's sex	764	0	1	-	-	-
Child's age (months)	764	34.00	90.00	59.07	12.28	57.00
Parental SES	758	-1.90	1.92	0.00	0.77	0.00
Household chaos	745	1	5	2.40	0.78	2.40
Restrictions on screen time	724	1	4	3.05	0.70	3.00
Restrictions on noninteractive screen time	716	1	4	2.80	0.70	3.00
Restrictions on interactive screen time	713	1	4	3.07	0.84	3.00
Child's screen time	751	0	4	1.67	0.85	1.67
Child's noninteractive screen time	747	0	4	2.31	1.09	2.00
Child's interactive screen time	749	0	4	1.34	0.96	1.00
Changes in screen time	734	1	5	3.52	0.88	3.67
Changes in noninteractive screen time	728	1	5	3.81	0.94	4.00
Changes in interactive screen time	718	1	5	3.36	0.98	3.50
Child's anxiety/withdrawal	743	1	4	1.38	0.36	1.33
Child's approach to learning	741	1	4	2.38	0.50	2.33

Note. $N=764$; Boys were coded as 0, and girls were coded as 1

Changes in children's screen time

Participants also reported the changes in their children's screen time after the pandemic outbreak (e.g., "How has the amount of time the child spent on watching TV or videos per day changed since the COVID-19 outbreak compared to before the pandemic?") using a set of three questions with a five-point scale (i.e., 5 = *Increased a lot*, 1 = *Decreased a lot*). The three questions focused on changes in time spent on TV or videos, computers or tablets, and smartphones, respectively. The measure was designed to assess how screen time changed after the pandemic outbreak while pre-pandemic data were unavailable under the circumstance. The Cronbach's alpha of the measure was 0.79. The scores of the three items were averaged to represent changes in screen time. The score of the first item was used to represent changes in noninteractive screen time, and the mean scores of the last two items represented changes in interactive screen time.

Children's anxiety and withdrawal

Children's anxiety and withdrawal were reported by their caregivers using the Anxiety and Withdrawal subscale of the Pediatric Emotional Distress Scale (PEDS) (Saylor et al., 1999) with a four-point scale. Compared to other measurements of anxiety, this particular measure was designed to assess children's emotional distress after experiencing traumatic events and thus was considered the best choice for our study given the key aspect of the research context being the pandemic. The Anxiety and Withdrawal measure consists of 6 items (e.g. "Please mark how frequently the child seems worried in the previous month?"), and the Cronbach's α was 0.69. Mean scores were computed to represent levels of anxiety and withdrawal. Higher scores in the scale represented more severe symptoms.

Approaches to learning

Approaches to learning were assessed using the short form of the Young Children's Approaches to Learning Scale reported by caregivers (Cai, 2015). The test consists of six items measuring children's learning behaviors, which include curiosity and eagerness to learn (e.g., "Please mark how frequently the child approached novelty things actively in the previous month."), persistence and attentiveness, initiative, imagination and creativity, reflection and explanation, on a four-point Likert scale. Mean scores were computed to represent approaches to learning. Higher scores indicated more positive approaches to learning. Cronbach's alpha coefficient was 0.81.

Household chaos

Household chaos was examined using the Chaos, Order and Hubbub Scale (CHAOS) (Matheny et al., 1995), which consisted of five items on a 5-point Likert scale. An example item is "I can't concentrate at home." We removed one item from the original measure because of its' factor loading was lower than 0.30. The scores of the five remaining items were averaged to represent household chaos and higher scores represent higher levels of chaos at home. The Cronbach's alpha of the measure was 0.70.

Caregivers' restrictions on screen time

Caregivers' restrictions on screen time were measured using five items, which asked the caregivers to report the frequency of their restriction behaviors after the pandemic (e.g., "I restricted the time my child spent watching TV or videos.") on a scale from 1 = *Rarely* to 4 = *Always*. The measure has been used in China and has shown a good reliability ($\alpha = 0.80$) (Hu et al., 2018). The average scores of the five items were calculated to represent caregivers' restrictions on screen time. The Cronbach's alpha of the measure was 0.82. The scores of the first item represented caregivers' restrictions on noninteractive screen time, and the average scores of the second and third items were computed to represent restrictions on interactive screen time. Higher scores indicate that parents placed more restrictions on children's screen time.

Family SES

Caregivers reported their annual family income in 2019 (on a scale from 1 = *Less than 10,000 RMB* to 21 = *More than 200,000 RMB*), paternal and maternal occupation (from 1 = *Farmer, nontechnical worker, or unemployed*, to 5 = *Professional or administrator, such as manager*), and paternal and maternal education (on a scale from 1 = *Elementary school or below* to 7 = *Doctoral degree*). We used the average of the standardized scores of the five SES indicators to represent SES (see also Zhang et al., 2020).

Data analysis

First, descriptive statistics and correlations between the variables were computed. Second, path model 1 (Fig. 1) was constructed to examine the children's total screen time and its' changes during the pandemic and their association with children's outcome variables, including approaches to learning and anxiety/withdrawal, and family correlates (i.e., household chaos and caregivers' restrictions on children's screen time). Third, path model 2 (Fig. 2) was constructed to

Fig. 1 Path Model 1: Total Screen Time, Changes in Total Screen Time, and Their Associations with Children’s Anxiety/Withdrawal, Approaches to Learning, and Familial Correlates

Note. All the paths were presented in the figure. The solid lines represent significant paths, and the dashed lines represent insignificant paths

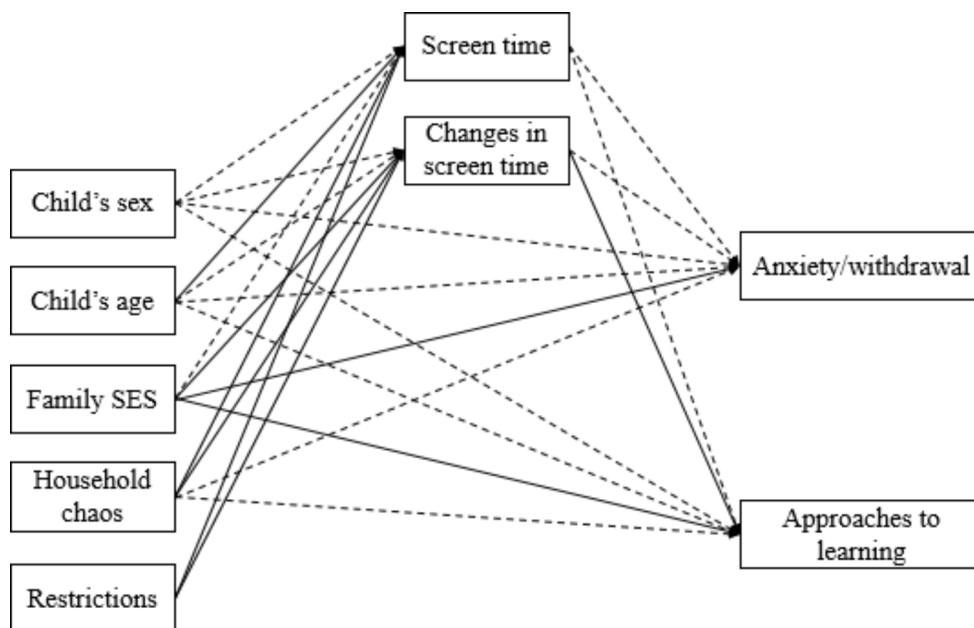
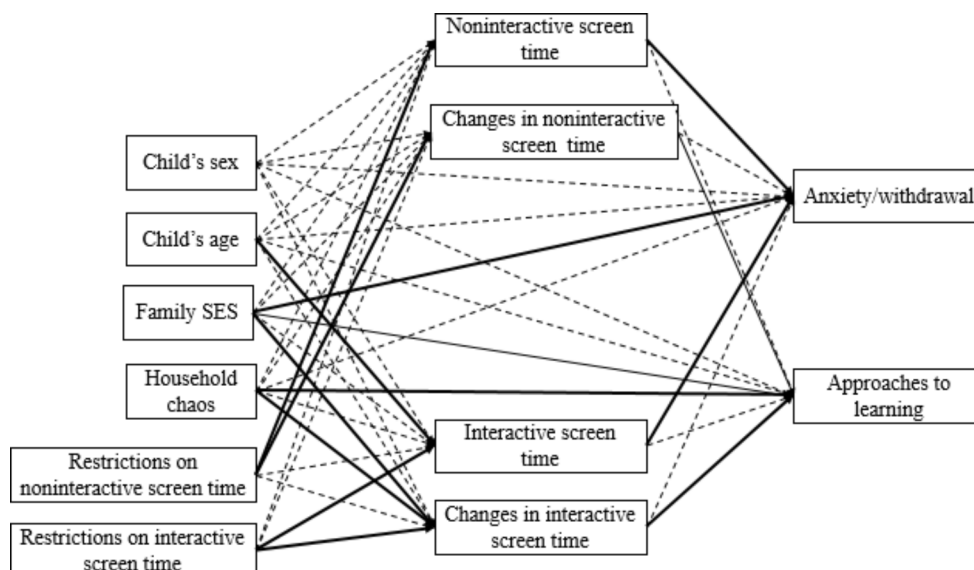


Fig. 2 Path Model 2: Noninteractive and Interactive Screen Time and Their Association with Children’s Anxiety/Withdrawal, Approaches to Learning, and Familial Correlates

Note. All the paths were presented in the figure. The solid lines represent significant paths, and the dashed lines represent insignificant paths



examine the two different types of screen time—noninteractive and interactive — and their association with children’s outcome variables and family correlates. Children’s sex, age, as well as family SES were included as covariates in each path of the two models. Household chaos also served as a covariate when investigating the relation between screen time and outcome variables, because chaos has been found to predict preschoolers’ learning and emotional problems (Kirkorian et al., 2009). However, caregivers’ restrictions on screen time were not included as a covariate because there is a lack of evidence in the literature regarding the relation between screen time restrictions and children’s learning behaviors and anxiety/withdrawal. Mplus Version 7.0 software was used to perform the data analyses, and

missing data was estimated by full information maximum likelihood (FIML) technique. The data, study materials, and data analysis codes are available upon request.

Results

Preliminary results

Table 1 shows the descriptive statistics concerning the study variables. Most mothers (58.7%) and fathers (60.3%) had a bachelor’s degree, and 17.4% of the mothers and 16.8% of the fathers had a high school degree. There were 21.3% of the households with an annual household income

below 50,000RMB, 25.3% with an annual income of 50,000RMB-100,000RMB, 25.3% with an annual income of 100,000RMB-150,000RMB, 14.1% with an annual income of 150,000RMB-200,000RMB, 15.2% with an annual income higher than 200,000RMB, and 24.9% non-responses. 49% of the mothers and 53.6% of the fathers were front-line management and technical workers (e.g., salesperson, driver) or middle management and technical workers (e.g., teacher, doctor) and 31.8% of the mothers and 7.2% of the fathers were either unemployed, non-technical workers, or farmers.

According to the caregivers' reports, 40.2% of the children watched TV for more than one hour per day, 36.5% watched between half an hour and one hour, and 21% watched less than half an hour. Regarding interactive screen time, 56% of the children spent less than half an hour per day on computer use, 25.1% spent half an hour to one hour, and 15.7% spent more than one hour. In addition, 58.9% of the children played with smartphones for less than half an hour per day, 22.9% played for half an hour to one hour, and 14.3% played for more than one hour. Regarding changes in screen time after the pandemic, 6.7% of the caregivers reported a decrease in their children's TV use, 22.8% reported no change, 44.1% reported a slight increase, and 21.7% reported a significant increase. In terms of computer use, 13.4% of the caregivers reported a decrease in their children's usage, 34% reported no change, 30.1% reported a slight increase, and 12.7% reported a significant change. Finally, 14.1% of the caregivers reported a decrease in their children's smartphone use, 35.6% reported no change, 29.7% reported a slight increase, and 12% reported a significant increase.

As indicated by Table 2, household chaos was positively correlated with increases in children's screen time ($p < .05$). To be more specific, children living in more chaotic families spent more time on interactive screen use ($p < .05$) and showed larger increases in interactive screen time ($p < .05$). With the increase in caregivers' restrictions on children's screen time, children tended to spend less time on screen use ($p < .01$) and showed smaller increases in screen time ($p < .01$) during the pandemic; this relation held true when examining both interactive and noninteractive screen time use ($ps < 0.01$). Regarding the relations between screen time and the outcome variables, children who spent more time on noninteractive screen use showed lower levels of anxiety and withdrawal ($p < .01$), whereas children who spent more time on interactive screen use showed higher levels of anxiety and withdrawal ($p < .05$). Besides, children who increased their interactive screen time had fewer positive approaches to learning ($p < .01$). Surprisingly, we found that caregivers' restrictions on interactive and noninteractive screen time were positively correlated with children's

Table 2 Correlation Matrix

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Child's sex	1														
2. Child's age (months)	-0.05	1													
3. Family SES	0.10**	-0.26**	1												
4. Household chaos	0.06	-0.04	0.004	1											
5. Caregivers' restriction on children's screen time	0.04	-0.01	0.14**	0.04	1										
6. Caregivers' restriction on noninteractive screen time	0.02	-0.04	0.16**	0.02	0.74**	1									
7. Caregivers' restriction on interactive screen time	0.04	-0.02	0.14**	0.00	0.87**	0.60**	1								
8. Child's screen time	0.01	0.15**	-0.09*	0.07	-0.26**	-0.20**	-0.27**	1							
9. Child's noninteractive screen time	0.02	0.06	-0.06	0.01	-0.14**	-0.16**	-0.11**	0.71**	1						
10. Child's interactive screen time	-0.004	0.16**	-0.10**	0.08*	-0.27**	-0.17**	-0.30**	0.92**	0.37**	1					
11. Changes in screen time	0.05	-0.02	0.07	0.08*	-0.19**	-0.20**	-0.21**	0.45**	0.29**	0.42**	1				
12. Changes in noninteractive screen time	0.05	-0.01	0.04	0.02	-0.16**	-0.20**	-0.12**	0.35**	0.43**	0.22**	0.80**	1			
13. Changes in interactive screen time	0.02	-0.02	0.07	0.08*	-0.19**	-0.17**	-0.24**	0.44**	0.18**	0.48**	-0.57**	0.95**	1		
14. Child's anxiety/withdrawal	-0.04	0.01	-0.14**	-0.02	-0.13**	-0.07	-0.10**	0.01	-0.10**	0.07*	-0.03	-0.03	-0.02	1	
15. Child's approaches to learning	0.06	-0.01	0.15**	-0.02	0.19**	0.16**	0.17**	-0.05	-0.003	-0.07	-0.08*	-0.03	-0.10**	-0.02	1

Note. N = 764; Boys were coded as 0, and girls were coded as 1

* $p < .05$, ** $p < .01$

approaches to learning ($ps < 0.01$). However, this correlation was not added in the path models because theoretically it did not make sense.

Total screen time and changes in total screen time: family correlates and associations with children’s anxiety/ withdrawal and approaches to learning

Table 3 presents the results of the path Model 1 (Fig. 1). The model fit was acceptable with $\chi^2 = 17.47$ ($p = .015$), CFI = 0.957, TLI = 0.841, RMSEA = 0.045, SRMR = 0.024. The results showed a negative correlation between changes in total screen time and children’s approaches to learning. This indicates that children with larger increases in screen time after the pandemic outbreak showed fewer positive approaches to learning. However, there was no significant association of children’s total screen time and its changes with their anxiety and withdrawal. The examination of the family correlates showed that children who were older, lived in households with higher levels of chaos, and had caregivers who imposed less frequent restrictions on screen time spent more time on screen use. Children living in higher-SES and more chaotic families and with caregivers who imposed less frequent restrictions on screen time reported larger increases in screen time after the pandemic outbreak.

Noninteractive and interactive screen time and their changes: family correlates and association with children’s anxiety/withdrawal and approaches to learning

Table 4 presents the standardized coefficients of the paths in Model 2 (Fig. 2). The model 2 fitted well with the data ($\chi^2 = 16.22$, $p = .003$, CFI = 0.985, TLI = 0.804, RMSEA = 0.063, SRMR = 0.019). The results demonstrated that children who spent more time on noninteractive screen use showed fewer anxiety/withdrawal symptoms. In contrast, children who spent more time on interactive screen

use showed higher levels of anxiety/withdrawal. In addition, we found children who increased their time on interactive screen after the pandemic outbreak showed fewer positive learning activities.

Furthermore, noninteractive and interactive screen time and their changes were associated with caregivers’ restrictions. The more restrictive the caregivers were with respect to children’s screen time, children would spend less time on and a smaller increase was found in the corresponding screen use during the pandemic. Moreover, interactive screen time and its changes, but not noninteractive screen time or its changes, were correlated with household chaos: children living in more chaotic homes spent more time on and showed larger increases in interactive screen use during the pandemic.

Discussion

School closures and home quarantine caused by the COVID-19 pandemic have raised concerns about increases in children’s screen time and the possible outcomes and correlates. This study indicated that there was a general increase in the screen use of the preschool children in Wuhan during the pandemic. About 40.2% of the caregivers reported that their children spent more than one hour on TV viewing, and about 15.7% and 14.3% of the caregivers reported that their children spent more than one hour playing on tablets and cellphones during the pandemic. The time of noninteractive and interactive screen use by these children exceeded the screen time criterion for preschool children recommended by WHO (2019), namely, a maximum of one hour a day. However, the screen time seems not to be very much compared to a recent study which indicated children spent more than 3 h on screen use during the COVID-19 (Aguilar-Farías et al., 2020). Partially consistent with the hypothesis 1, the study found that noninteractive screen time was negatively correlated with levels of anxiety/withdrawal, whereas

Table 3 Standardized Path Coefficients in the Path Model Predicting Children’s Screen Time, Anxiety/Withdrawal, and Approaches to Learning

Predictors	Screen Time		Changes in Screen Time		Children’s Anxiety/Withdrawal		Children’s Approaches to Learning	
	β	S.E.	β	S.E.	β	S.E.	β	S.E.
Child’s sex	0.027	0.035	0.036	0.036	−0.029	0.035	0.054	0.036
Child’s age (months)	0.145***	0.036	0.015	0.037	−0.033	0.040	0.032	0.039
Family SES	−0.020	0.036	0.091*	0.040	−0.145***	0.039	0.158***	0.040
Household chaos	0.075*	0.036	0.080*	0.038	−0.014	0.035	−0.016	0.039
Caregivers’ restriction on children’s screen time during pandemic	−0.263***	0.038	−0.21***	0.045	-	-	-	-
Child’s screen time	-	-	-	-	0.010	0.039	0.007	0.045
Changes in screen time	-	-	-	-	−0.016	0.042	−0.100*	0.042

Note. Sex: 0 = boy, 1 = girl. * $p < .05$; ** $p < .01$; *** $p < .001$. N = 764

Table 4 Standardized Path Coefficients in the Path Model Predicting Children's Interactive and TV Viewing Time, Anxiety/Withdrawal, and Approach to Learning

Predictors	Screen Time			Changes in Screen Time			Children's Anxiety/Withdrawal			Children's Approaches to Learning		
	TV		Interactive media		TV		Interactive media		Withdrawal		Learning	
	β	S.E.	β	S.E.	β	S.E.	β	S.E.	β	S.E.	β	S.E.
Child's sex	0.024	0.036	0.018	0.035	0.041	0.037	0.016	0.036	-0.028	0.034	0.051	0.036
Child's age (months)	0.051	0.038	0.155***	0.036	0.007	0.036	0.023	0.037	-0.046	0.038	0.034	0.039
Family SES	-0.027	0.037	-0.015	0.036	0.071	0.039	0.107**	0.040	-0.143**	0.038	0.159**	0.039
Household chaos	0.020	0.038	0.074	0.035	0.013	0.038	0.086*	0.038	-0.016	0.034	-0.011	0.039
Caregivers' restriction on TV viewing time	-0.155**	0.051	0.035	0.047	-0.208***	0.052	-0.052	0.051	-	-	-	-
Caregivers' restriction on interactive screen time	-0.004	0.051	-0.323***	0.046	-0.006	0.054	-0.227***	0.052	-	-	-	-
Child's TV viewing time	-	-	-	-	-	-	-	-	-0.174**	0.052	0.025	0.046
Child's interactive screen time	-	-	-	-	-	-	-	-	0.158**	0.049	-0.013	0.047
Changes in TV viewing time	-	-	-	-	-	-	-	-	0.071	0.060	0.019	0.054
Changes in interactive screen time	-	-	-	-	-	-	-	-	-0.091	0.058	-0.123*	0.051

Note. Sex: 0 = boy, 1 = girl. * $p < .05$; ** $p < .01$; *** $p < .001$. N = 764

interactive screen time positively predicted levels of anxiety/withdrawal. Furthermore, accordance with hypothesis 2, children who increased the time they spent on screen use, especially on interactive screen use, showed fewer positive approaches to learning. Moreover, the study also corroborates the hypothesis 3: children living in more chaotic family households and with fewer restrictions on screen time showed more time spent on screen use and larger increases in screen time after the pandemic outbreak.

Screen time, changes in screen time and their association with anxiety/ withdrawal and approaches to learning

The results did not show significant effects of children's total screen time on their anxiety/withdrawal. However, a further investigation indicated that noninteractive and interactive screen time associated with children's levels of anxiety and withdrawal, but in different ways: children's noninteractive screen use negatively associated with levels of anxiety/withdrawal, whereas interactive screen use positively associated with levels of anxiety/withdrawal. The results concerning the negative relation between non-interactive screen use and anxiety/withdrawal are surprising because previous studies have indicated the opposite, that is, that TV viewing increases children's anxiety (Mistry et al., 2007; Kremer et al., 2014; Singer et al., 1998). However, it is worth noting that those studies mainly focused on the influence of excessive screen use. Considering the relatively low-dose of children's TV viewing time (81.1% of the children spent less than one hour on TV viewing) in the present study, our findings are not that surprising and are in fact consistent with a few studies indicating that preschoolers with low-dose screen use tend to have fewer psychosocial difficulties compared to non-users (McNeill et al., 2019). There are two possible explanations for the negative relation between noninteractive screen time and levels of anxiety/withdrawal during the pandemic. First, the COVID-19 pandemic, leading to the home quarantine of all family members, may increase the time that children spent on watching TV or videos with their parents (Farber et al., 2020), which could promote parent-child interaction and benefit children's mental health. Second, as Radesky and colleagues (2020) suggested, screen media may serve as a distraction or entertainment when children encounter some stressful events, such as the pandemic.

In contrast to noninteractive screen time, more time spent on interactive screen use tended to be associated with higher levels of anxiety/withdrawal. This finding is in line with a number of findings pertaining to older children. For instance, prior research has indicated detrimental effects of computer use or video games on primary school children's

and teenagers' mental health (Przybylski, 2014; Elson & Ferguson, 2013; Mentzoni et al., 2011). To illustrate, unlike TV viewing, which could alleviate personal stress by increasing the interactions between family members, most interactive screen use involving an individual's own computer or smartphone is mainly conducted in isolation (Farber et al., 2020) and could thus lead to increases in the individual's level of anxiety (Choate et al., 2005). Moreover, the present study found that children's exposure to interactive screen use was related to household chaos, so their interactive screen use may have been unsupervised. Unsupervised use of interactive screen media may increase the risk of children's exposure to violent video games or more mature content, and thus affect their levels of anxiety/withdrawal (Nikkelen et al., 2014). Another possible explanation is that children with higher levels of anxiety/withdrawal may use screens more frequently. The explanation is consistent with Tao et al.'s (2022) finding that individuals' anxiety levels were predictive of their sedentary time in the future.

The results also showed that children who increased the time spent on interactive screen after the pandemic outbreak showed fewer positive approaches to learning. These findings corroborate those of previous findings that increases in children's interactive screen time negatively affected children's learning behaviors, such as learning motivation and attention (Nikkelen et al., 2014). We, therefore, speculate that increases in interactive screen time after the pandemic outbreak displaced the time spent on other valuable cognitive activities they liked to engage in before the pandemic, such as outdoor learning activities, reading books (Anderson & Subrahmanyam, 2017), or learning with teachers and peers, which could influence their approaches to learning.

Screen time, changes in screen time and their familial correlates

The results indicated that children living in more chaotic households tended to show increases in interactive screen time after the pandemic outbreak. This finding was in line with Emond et al. (2018) and can be explained in two ways. First, caregivers who live in more chaotic households may be more likely to use media to occupy children when they were working or doing household chores, or to distract children temporarily from disorderly behavior. Unlike the time spent on TV or video viewing, which usually depends on the length of the TV programs or videos, time spent on interactive media use is fragmented and such interactive media use is easier to stop. Second, caregivers in more chaotic families may have less time to monitor their children, so the children may be able to use smartphones or tablets without their caregivers noticing.

The findings regarding the association between caregivers' restrictions on screen time and young children's screen use are also consistent with previous studies (Saelens et al., 2002). The results, therefore, support that caregivers' restrictions on screen time may be an effective approach in reducing children's screen time. This suggests that interventions can be designed to help parents to set daily routines, including screen use routines, and establish a good habit of using electronic media for their children (Vanderloo et al., 2020).

Limitations, future directions, and implications

This study has several limitations. First, this study is a cross-sectional study, which does not allow us to infer any causal relations between the variables, and thus the results should be carefully interpreted and generalized. For example, children with higher levels of emotional needs may use screens as a tool to calm down and self-regulate. Future studies should use longitudinal designs. Second, we only adopted caregiver-report measures, which might have influenced the results because of the shared method variance. Third, under the circumstances where pre-pandemic data was unavailable, we requested the participants to provide information on the change in their children's screen time before and after the COVID-19 outbreak. However, such information may be subject to recall bias, which may affect accuracy of the participants' report. Fourth, some of the variables in the study, such as TV viewing time and changes in TV viewing time, were measured by only one item, which might have reduced the reliability of the measures. In future studies, it would be helpful to use more items or methods, such as time diaries, to measure children's screen time. Fifth, the present study only examined the children's screen time but did not consider the screen content or programs that children watched or used. As Radesky and colleagues (2020) reported, children usually use tablets and smartphones to watch videos and quick search on Siri, which indeed involves little interaction with the devices. In the future, the content of screen use should be taken into consideration. Finally, the regression coefficients in the path models should be interpreted with caution because their effect sizes ranged between weak ($\beta=0.075$) and moderate ($\beta = -0.323$). Nonetheless, our findings hold significant importance because they reveal the significant impact of interactive and noninteractive screen time on children's learning and anxiety and withdrawal during the pandemic as well as provide guidance on managing children's screen time. These findings offer valuable insights for policymakers, practitioners, and caregivers who are making decisions about the use of media for educational and entertainment purposes at home during the pandemic.

In spite of these limitations, this study contributes to the literature and practice in several ways. First, we documented preschool children's screen time during the pandemic, which provides insights into how young children spent their screen time at home during the pandemic. Second, this study found that young children's frequent use of interactive screens, such as tablets and smartphones, was associated with increased levels of anxiety and withdrawal and decreased interest and motivation to learn during the pandemic. Although some Chinese preschools encourage preschool children to use tablets to learn and entertain at home (Dong et al., 2020), the WHO (2019) recommended that the time be restricted to less than one hour per day. Caregivers may consider using other tools, such as Legos, card games (Singh et al., 2021), and story books (Robbins & Ehri, 1994), to facilitate children's learning and entertainment at home. Moreover, reducing household chaos by setting daily routines may help reduce children's time spent on tablets and smartphones. Third, this study found a negative correlation between children's anxiety/withdrawal and TV viewing during the pandemic. Specifically, allowing children to watch TV may help them alleviate anxiety and withdrawal during the pandemic. However, it is important to exercise caution when encouraging children to spend more time watching TV given the relatively low dose of TV viewing in the present study.

Funding The University of Hong Kong provided financial support for the conduct of the research via its Research Output Prize to the corresponding author. The funding source had no involvement in the study design, the collection, analysis, and interpretation of data, the preparation and writing of the report, or the decision to submit the article for publication.

Declarations

Conflict of interest The authors declare no conflict of interest.

References

- Aguilar-Farias, N., Toledo-Vargas, M., Miranda-Marquez, S., Cortinez-O'Ryan, A., Cristi-Montero, C., Rodriguez-Rodriguez, F., Martino-Fuentealba, P., Okely, A. D., & del Pozo Cruz, B. (2020). Sociodemographic predictors of changes in physical activity, screen time, and sleep among toddlers and preschoolers in Chile during the COVID-19 pandemic. *International Journal of Environmental Research and Public Health*, *18*(1), 176. <https://doi.org/10.3390/ijerph18010176>.
- Allen, M. S., & Vella, S. A. (2015). Screen-based sedentary behaviour and psychosocial well-being in childhood: Cross-sectional and longitudinal associations. *Mental Health and Physical Activity*, *9*, 41–47. <https://doi.org/10.1016/j.mhpa.2015.10.002>.
- Anderson, D. R., & Subrahmanyam, K. (2017). Digital screen media and cognitive development. *Pediatrics*, *140*(Supplement 2), <https://doi.org/10.1542/peds.2016-1758>. S57-S61.
- Cai, X. (2015). *The development and pilot testing of an assessment tool of senior preschoolers' approaches to learning* Unpublished Master's dissertation. Shaanxi Normal University, Shaanxi.
- Cassinat, J. R., Whiteman, S. D., Serang, S., Dotterer, A. M., Mustillo, S. A., Maggs, J. L., & Kelly, B. (2021). Changes in family chaos and family relationships during the COVID-19 pandemic: Evidence from a longitudinal study. *Developmental Psychology*, *57*(10), 1597–1610. <https://doi.org/10.1037/dev0001217>.
- Chassiakos, Y. L., Radesky, J., Christakis, D., Moreno, M. A., & Cross, C. (2016). Children and adolescents and digital media. *Pediatrics*, *138*(5), e20162593. <https://doi.org/10.1542/peds.2016-2593>.
- Choate, M. L., Pincus, D. B., Eyberg, S. M., & Barlow, D. H. (2005). Parent-child interaction therapy for treatment of separation anxiety disorder in young children: A pilot study. *Cognitive and Behavioral Practice*, *12*(1), 126–135. [https://doi.org/10.1016/S1077-7229\(05\)80047-1](https://doi.org/10.1016/S1077-7229(05)80047-1).
- Chonchaiya, W., Sirachairat, C., Vijakkhana, N., Wilaisakditipakorn, T., & Pruksananonda, C. (2015). Elevated background TV exposure over time increases behavioural scores of 18-month-old toddlers. *Acta Paediatrica*, *104*(10), 1039–1046. <https://doi.org/10.1111/apa.13067>.
- Collier, K. M., Coyne, S. M., Rasmussen, E. E., Hawkins, A. J., Padilla-Walker, L. M., Erickson, S. E., & Memmott-Elison, M. K. (2016). Does parental mediation of media influence child outcomes? A meta-analysis on media time, aggression, substance use, and sexual behavior. *Developmental Psychology*, *52*(5), 798–812. <https://doi.org/10.1037/dev0000108>.
- Dong, C., Cao, S., & Li, H. (2020). Young children's online learning during COVID-19 pandemic: Chinese parents' beliefs and attitudes. *Children and Youth Services Review*, *118*, 105440.
- Downing, K. L., Hinkley, T., & Hesketh, K. D. (2015). Associations of parental rules and socioeconomic position with preschool children's sedentary behaviour and screen time. *Journal of Physical Activity and Health*, *12*, 512–521. <https://doi.org/10.1123/jpah.2013-0427>.
- Duch, H., Fisher, E. M., Ensari, I., & Harrington, A. (2013). Screen time use in children under 3 years old: A systematic review of correlates. *International Journal of Behavioral Nutrition and Physical Activity*, *10*(1), 102. <https://doi.org/10.1186/1479-5868-10-102>.
- Elson, M., & Ferguson, C. J. (2013). Gun violence and media effects: Challenges for science and public policy. *The British Journal of Psychiatry*, *203*(5), 322–324. <https://doi.org/10.1192/bjp.bp.113.128652>.
- Emond, J. A., Tantum, L. K., Gilbert-Diamond, D., Kim, S. J., Lansigan, R. K., & Neelon, S. B. (2018). Household chaos and screen media use among preschool-aged children: A cross-sectional study. *Bmc Public Health*, *18*(1), 1–8. <https://doi.org/10.1186/s12889-018-6113-2>.
- Fantuzzo, J., Perry, M. A., & McDermott, P. (2004). Preschool approaches to learning and their relationship to other relevant classroom competencies for low-income children. *School Psychology Quarterly*, *19*(3), 212. <https://doi.org/10.1521/scpq.19.3.212.40276>.
- Farber, B. A., Ort, D., & Mayopoulos, G. (2020). Psychotherapists' preferences for television and movies during the early stages of the COVID-19 pandemic. *Journal of Clinical Psychology*, *76*(8), 1532–1536. <https://doi.org/10.1002/jclp.23005>.
- Gupta, R. K., Saini, D. P., Acharya, U., & Miglani, N. (1994). Impact of television on children. *The Indian Journal of Pediatrics*, *61*(2), 153–159. <https://doi.org/10.1007/BF02843606>.
- Hamer, M., Stamatakis, E., & Mishra, G. (2009). Psychological distress, television viewing, and physical activity in children aged 4 to 12 years. *Pediatrics*, *123*(5), 1263–1268. <https://doi.org/10.1542/peds.2008-1523>.
- Hu, B. Y., Johnson, G. K., & Wu, H. (2018). Screen time relationship of Chinese parents and their children. *Children and Youth*

- Services Review, 94, 659–669. <https://doi.org/10.1016/j.childyouth.2018.09.008>.
- Jiang, X., Hardy, L. L., Ding, D., Baur, L. A., & Shi, H. (2014). Recreational screen-time among chinese adolescents: A cross-sectional study. *Journal of Epidemiology*, 24(5), 397–403. <https://doi.org/10.2188/jea.je20140006>.
- Johnson, J. G., Cohen, P., Kasen, S., & Brook, J. S. (2007). Extensive television viewing and the development of attention and learning difficulties during adolescence. *Archives of Pediatrics and Adolescent Medicine*, 161(5), 480–486. <https://doi.org/10.1001/archpedi.161.5.480>.
- Kagan, S. L., Moore, E. K., & Bredekamp, S. (1995). *Reconsidering children's early development and learning: Toward common views and vocabulary* (95 vol.). National Education Goals Panel. 3.
- Kirkorian, H. L., Pempek, T. A., Murphy, L. A., Schmidt, M. E., & Anderson, D. R. (2009). The impact of background television on parent-child interaction. *Child Development*, 80(5), 1350–1359. <https://doi.org/10.1111/j.1467-8624.2009.01337.x>.
- Knudsen, E. (2004). Sensitive periods in the development of the brain and behavior. *Journal of Cognitive Neuroscience*, 16(8), 1412–1425. <https://doi.org/10.1162/0898929042304796>.
- Koh, W. Y., Alikhan, M. F., Koh, D., & Wong, J. J. (2020). Containing COVID-19: Implementation of early and moderately stringent social distancing measures can prevent the need for large-scale lockdowns. *Annals of Global Health*, 86(1), <https://doi.org/10.5334/aogh.2969>.
- Kracht, C. L., Katzmarzyk, P. T., & Staiano, A. E. (2021). Household chaos, maternal stress, and maternal health behaviors in the United States during the COVID-19 outbreak. *Women's Health*, 17, 1–10. <https://doi.org/10.1177/17455065211010655>.
- Kremer, P., Elshaug, C., Leslie, E., Tombourou, J. W., Patton, G. C., & Williams, J. (2014). Physical activity, leisure-time screen use and depression among children and young adolescents. *Journal of Science and Medicine in Sport*, 17(2), 183–187. <https://doi.org/10.1016/j.jsams.2013.03.012>.
- Lin, C. A., & Atkin, D. J. (1989). Parental mediation and rulemaking for adolescent use of television and VCRs. *Journal of Broadcasting & Electronic Media*, 33(1), 53–67. <https://doi.org/10.1080/08838158909364061>.
- Liu, W., Wu, X., Huang, K., et al. (2021). Early childhood screen time as a predictor of emotional and behavioral problems in children at 4 years: A birth cohort study in China. *Environmental Health and Preventive Medicine*, 26, 3. <https://doi.org/10.1186/s12199-020-00926-w>.
- Marinelli, M., Sunyer, J., Alvarez-Pedrerol, M., Iniguez, C., Torrent, M., Vioque, J., Turner, M. C., & Julvez, J. (2014). Hours of television viewing and sleep duration in children. *JAMA Pediatrics*, 168(5), 458. <https://doi.org/10.1001/jamapediatrics.2013.3861>.
- Martin, A., Razza, R. A., & Brooks-Gunn, J. (2012). Specifying the links between household chaos and preschool children's development. *Early Child Development and Care*, 182(10), 1247–1263. <https://doi.org/10.1080/03004430.2011.605522>.
- Matheny, A. P. Jr., Wachs, T. D., Ludwig, J. L., & Phillips, K. (1995). Bringing order out of chaos: Psychometric characteristics of the confusion, hubbub, and order scale. *Journal of Applied Developmental Psychology*, 16(3), 429–444. [https://doi.org/10.1016/0193-3973\(95\)90028-4](https://doi.org/10.1016/0193-3973(95)90028-4).
- McNeill, J., Howard, S. J., Vella, S. A., & Cliff, D. P. (2019). Longitudinal associations of electronic application use and media program viewing with cognitive and psychosocial development in preschoolers. *Academic Pediatrics*, 19(5), 520–528. <https://doi.org/10.1016/j.acap.2019.02.010>.
- Mentzoni, R. A., Brunborg, G. S., Molde, H., Myrseth, H., Skouvrøe, K. J. M., Hetland, J., & Pallesen, S. (2011). Problematic video game use: Estimated prevalence and associations with mental and physical health. *Cyberpsychology Behavior and Social Networking*, 14(10), 591–596.
- Ministry of Education. (2020). *Using the internet platform to continue learning when classes stop (in chinese)*. Beijing: The Author.
- Mistry, K. B., Minkovitz, C. S., Strobino, D. M., & Borzekowski, D. L. G. (2007). Children's television exposure and behavioral and social outcomes at 5.5 years: Does timing of exposure matter? *Pediatrics*, 120(4), 762–769. <https://doi.org/10.1542/peds.2006-3573>.
- Nikkelen, S. W., Valkenburg, P. M., Huizinga, M., & Bushman, B. J. (2014). Media use and ADHD-related behaviors in children and adolescents: A meta-analysis. *Developmental Psychology*, 50(9), 2228–2241. <https://doi.org/10.1037/a0037318>.
- Pagani, L. S., Fitzpatrick, C., & Barnett, T. A. (2013). Early childhood television viewing and kindergarten entry readiness. *Pediatric Research*, 74(3), 350–355. <https://doi.org/10.1038/pr.2013.105>.
- Page, A. S., Cooper, A. R., Griew, P., & Jago, R. (2010). Children's screen viewing is related to psychological difficulties irrespective of physical activity. *Pediatrics*, 126(5), e1011–e1017. <https://doi.org/10.1542/peds.2010-1154>.
- Patimah, P., & Kiswaya, Y. (2019). The influence of television watching intensity on the students' learning interest. *Al Ibtida: Jurnal Pendidikan Guru MI*, 6(1), 134–143. <https://doi.org/10.24235/al.ibtida.snj.v6i1.3640>.
- Przybylski, A. K. (2014). Electronic gaming psychosocial adjustment. *Pediatrics*, 134(3), e716–e722. <https://doi.org/10.1542/peds.2013-4021>.
- Radesky, J. S. (2018). Digital media and children: The good, the bad, and the unknown. *Paper presented at The American Academy of Pediatrics (AAP) 2018 National Conference and Exhibition*. Orlando, Florida.
- Radesky, J., Silverstein, M., Zuckerman, B., & Christakis, D. A. (2014). Infant self-regulation and early childhood media exposure. *Pediatrics*, 133(5), e1172–e1178. <https://doi.org/10.1542/peds.2013-2367>.
- Radesky, J. S., Weeks, H. M., Ball, R., Schaller, A., Yeo, S., Durnez, J., Tamayo-Rios, M., Epstein, M., Kirkorian, H., Coyne, S., & Barr, R. (2020). Young children's use of smartphones and tablets. *Pediatrics*, 146(1), e20193518. <https://doi.org/10.1542/peds.2019-3518>.
- Rahayu, I. S., Bose, P., Hardiansyah, M. Y., Dewi, D. E. O., & Elihami, E. (2021). Relationship of online game addiction with learning motivation in school age children on COVID-19 pandemic. *Linguistics and Culture Review*, 5(1), <https://doi.org/10.21744/ling-cure.v5n1.1650>.
- Rhee, H. (2008). Childhood overweight and the relationship between parent behaviors, parenting style, and family functioning. *Annals of the American Academy of Political and Social Science*, 615(1), 12–37.
- Rhodes, R. E., Blanchard, C. M., Quinlan, A., Naylor, P., & Warburton, D. E. R. (2019). Family physical activity planning and child physical activity outcomes: A randomized trial. *American Journal of Preventive Medicine*, 57(2), 135–144. <https://doi.org/10.1016/j.amepre.2019.03.007>.
- Robbins, C., & Ehri, L. C. (1994). Reading storybooks to kindergartners helps them learn new vocabulary words. *Journal of Educational Psychology*, 86(1), 54–64. <https://doi.org/10.1037/0022-0663.86.1.54>.
- Rundle, A. G., Park, Y., Herbstman, J. B., Kinsey, E. W., & Wang, Y. C. (2020). COVID-19-related school closings and risk of weight gain among children. *Obesity (Silver Spring, Md.)*, 28(6), 1008–1009. <https://doi.org/10.1002/oby.22813>.
- Saelens, B. E., Sallis, J. F., Nader, P. R., Broyles, S. L., Berry, C. C., & Taras, H. L. (2002). Home environmental influences on children's television watching from early to middle childhood. *Journal of*

- Developmental and Behavioral Pediatrics*, 23(3), 127–132. <https://doi.org/10.1097/00004703-200206000-00001>.
- Salmon, J., Timperio, A., Telford, A., Carver, A., & Crawford, D. (2005). Association of family environment with children's television viewing and with low level of physical activity. *Obesity Research*, 13(11), 1939–1951. <https://doi.org/10.1038/oby.2005.239>.
- Saylor, C. F., Swenson, C. C., Stokes Reynolds, S., & Taylor, M. (1999). The Pediatric Emotional Distress Scale: A brief screening measure for young children exposed to traumatic events. *Journal of Clinical Child Psychology*, 28(1), 70–81. https://doi.org/10.1207/s15374424jccp2801_6.
- Singer, M. I., Slovak, K., Frierson, T., & York, P. (1998). Viewing preferences, symptoms of psychological trauma, and violent behaviors among children who watch television. *Journal of the American Academy of Child and Adolescent Psychiatry*, 37(10), 1041–1048. <https://doi.org/10.1097/00004583-199810000-00014>.
- Singh, P., Hoon, T. S., Nasir, A. H. M., Ramly, A., Rased, S. M., & Meng, C. C. (2021). Card game as a pedagogical tool for numeracy skills development. *International Journal of Evaluation and Research in Education*, 10(2), 693. <https://doi.org/10.11591/ijere.v10i2.20722>.
- Song, Y., Li, L., Xu, Y., Pan, G., Tao, F., & Ren, L. (2020). Associations between screen time, negative life events, and emotional and behavioral problems among chinese children and adolescents. *Journal of Affective Disorders*, 264, 506–512. <https://doi.org/10.1016/j.jad.2019.11.082>.
- Suarsi, P. D. K., & Wibawa, I. M. C. (2021). The impact of the COVID-19 pandemic on student learning motivation. *Jurnal Ilmiah Sekolah Dasar*, 5(2), 194–201.
- Susilowati, I. H., Nugraha, S., Alimoeso, S., & Hasiholan, B. P. (2021). Screen time for preschool children: Learning from home during the COVID-19 pandemic. *Global Pediatric Health*, 8, 2333794X2110178. <https://doi.org/10.1177/2333794x211017836>.
- Sweetsers, P., Johnson, D., Ozdowska, A., & Wyeth, P. (2012). Game-Flow heuristics for designing and evaluating real-time strategy games. In *ACM International Conference Proceeding Series*. <https://doi.org/10.1145/2336727.2336728>
- Taheri, E., Heshmat, R., Motlagh, M. E., Ardalan, G., Asayesh, H., Qorbani, M., & Kelishadi, R. (2019). Association of physical activity and screen time with psychiatric distress in children and adolescents: CASPIAN-IV study. *Journal of Tropical Pediatrics*, 65(4), 361–372. <https://doi.org/10.1093/tropej/fmy063>.
- Tamana, S. K., Ezeugwu, V., Chikuma, J., Lefebvre, D. L., Azad, M. B., Moraes, T. J., Subbarao, P., Becker, A. B., Turvey, S. E., Sears, M. R., Dick, B. D., Carson, V., Rasmussen, C., Pei, J., & Mandhane, P. J. (2019). Screen-time is associated with inattention problems in preschoolers: Results from the CHILD birth cohort study. *PLOS ONE*, 14(4), e0213995. <https://doi.org/10.1371/journal.pone.0213995>.
- Tan, T. X., & Zhou, Y. (2022). Screen time and ADHD behaviors in chinese children: Findings from longitudinal and cross-sectional data. *Journal of Attention Disorders*, 26(13), 1725–1737. <https://doi.org/10.1177/10870547221098181>.
- Tao, R., Liang, S., Bao, C., et al. (2022). Relationships between physical activity, sedentary behavior and anxiety in chinese children with visual impairment: A cross-lagged analysis. *Journal of Developmental and Physical Disabilities*. <https://doi.org/10.1007/s10882-022-09879-0>.
- Torsheim, T., Eriksson, L., Schnohr, C., Hansen, F., Bjarnason, T., & Välimaa, R. (2010). Screen-based activities and physical complaints among adolescents from the nordic countries. *Bmc Public Health*, 10(1), <https://doi.org/10.1186/1471-2458-10-324>.
- Trott, M., Driscoll, R., Iraldo, E., & Pardhan, S. (2022). Associations between vitamin D status and sight threatening and non-sight threatening diabetic retinopathy: A systematic review and meta-analysis. *Journal of Diabetes and Metabolic Disorders*. <https://doi.org/10.1007/s40200-022-01059-3>.
- Valkenburg, P. M., & Peter, J. (2013). The differential susceptibility to media effects model. *Journal of Communication*, 63(2), 221–243. <https://doi.org/10.1111/jcom.12024>.
- Van den Bulck, J., & Van den Bergh, B. (2000). The influence of perceived parental guidance patterns on children's media use: Gender differences and media displacement. *Journal of Broadcasting & Electronic Media*, 44(3), 329–348. https://doi.org/10.1207/s15506878jobem4403_1.
- Vanderloo, L. M., Carsley, S., Aglipay, M., Cost, K. T., Maguire, J., & Birken, C. S. (2020). Applying harm reduction principles to address screen time in young children amidst the COVID-19 pandemic. *Journal of Developmental & Behavioral Pediatrics*, 41(5), 335–336. <https://doi.org/10.1097/dbp.0000000000000825>.
- Vandewater, E. A., Park, S. E., Huang, X., & Wartella, E. A. (2005). No – you can't watch that": Parental rules and young children's media use. *American Behavioral Scientist*, 48(5), 608–623. <https://doi.org/10.1177/0002764204271497>.
- Vernon, L., Modecki, K. L., & Barber, B. L. (2018). Mobile phones in the bedroom: Trajectories of sleep habits and subsequent adolescent psychosocial development. *Child Development*, 89(1), 66–77. <https://doi.org/10.1111/cdev.12836>.
- Wang, G., Zhang, Y., Zhao, J., Zhang, J., & Jiang, F. (2020). Mitigate the effects of home confinement on children during the COVID-19 outbreak. *The Lancet*, 395(10228), 945–947. [https://doi.org/10.1016/s0140-6736\(20\)30547-x](https://doi.org/10.1016/s0140-6736(20)30547-x).
- Wang, X., Wu, Y., Yao, C., Wu, X., Ruan, Y., & Ye, S. (2022). Correlates of preschoolers' screen time in China: Parental factors. *BMC Pediatrics*, 22(1), <https://doi.org/10.1186/s12887-022-03443-7>.
- Watt, E., Fitzpatrick, C., Derevensky, J. L., & Pagni, L. S. (2015). Too much television? Prospective associations between early childhood televisioning and later self-reports of victimization by sixth grade classmates. *Journal of Developmental and Behavioral Pediatrics*, 36(6), 426–433. <https://doi.org/10.1097/dbp.0000000000000186>.
- Woods, H. C., & Scott, H. (2016). #sleepyteens: Social media use in adolescence is associated with poor sleep quality, anxiety, depression and low self-esteem. *Journal of adolescence*, 51, 41–49. <https://doi.org/10.1016/j.adolescence.2016.05.008>.
- World Health Organization. (2019). Guidelines on physical activity, sedentary behaviour and sleep for children under 5 years of age. *World Health Organization* <https://apps.who.int/iris/handle/10665/311664>. License: CC BY-NC-SA 3.0 IGO
- Xiang, M., Zhang, Z., & Kuwahara, K. (2020). Impact of COVID-19 pandemic on children and adolescents' lifestyle behavior larger than expected. *Progress in Cardiovascular Diseases*, 63(4), 531–532. <https://doi.org/10.1016/j.pcad.2020.04.013>.
- Xu, H., Wen, L. M., & Rissel, C. (2015). Associations of parental influences with physical activity and screen time among young children: a systematic review. *Journal of Obesity*, 2015. <https://doi.org/10.1155/2015/546925>
- Yue, J., Zang, X., Le, Y., & An, Y. (2022). Anxiety, depression and PTSD among children and their parent during 2019 novel coronavirus disease (COVID-19) outbreak in China. *Current Psychology*, 41(8), 5723–5730. <https://doi.org/10.1007/s12144-020-01191-4>.
- Zhang, X. (2022). Household chaos and caregivers' and young children's mental health during the COVID-19 pandemic: A mediation model. *Journal of Child and Family Studies*, 31(6), 1547–1557. <https://doi.org/10.1007/s10826-022-02283-4>.
- Zhang, X., Hu, B. Y., Zou, X., & Ren, L. (2020). Parent-child number application activities predict children's math trajectories from preschool to primary school. *Journal of Educational Psychology*. <https://doi.org/10.1037/edu0000457>.

- Zhao, J., Zhang, Y., Jiang, F., Ip, P., Ho, F. K. W., Zhang, Y., & Huang, H. (2018). Excessive screen time and psychosocial well-being: The mediating role of body mass index, sleep duration, and parent-child interaction. *The Journal of pediatrics*, *202*, 157–162. <https://doi.org/10.1016/j.jpeds.2018.06.029>.
- Zimmerman, F. J., Glew, G. M., Christakis, D. A., & Katon, W. (2005). Early cognitive stimulation, emotional support, and television watching as predictors of subsequent bullying among grade-school children. *Archives of Pediatrics and Adolescent Medicine*, *159*(4), 384–388. <https://doi.org/10.1001/archpedi.159.4.384>.

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Springer Nature or its licensor (e.g. a society or other partner) holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.