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Maternal adverse childhood experiences were associated with early screen exposure and prolonged daily screen time in preschool children

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Abstract

Background Maternal adverse childhood experiences (ACEs) have been linked to negative outcomes in their children. However, limited research has explored their impacts on screen use habits in preschool children. This study aimed to examine the associations of maternal ACEs with early screen exposure and prolonged daily screen time in preschool children whose mothers were their primary caregivers.

Methods A cross-sectional study was conducted involving 3,131 mother-child dyads in China. Twelve maternal ACEs were assessed using the Adverse Childhood Experiences-International Questionnaire and subsequently categorized into 0, 1, 2, 3, and ≥ 4 ACEs. Early onset of screen use was defined as exposure to screens before the age of 2 years, while prolonged daily screen time was defined as ≥ 1 h/day for children aged 5 years or younger and ≥ 2 h/day for those older than 5 years. Logistic regression analyses were performed to evaluate the associations between maternal ACEs and children's screen use behaviors. Stratified analyses and tests for interaction were carried out based on children's age, gender, single-child status, and maternal age.

Results Among the children included, 51.6% were boys, and the mean age was 4.6 (SD: 1.0) years. Approximately 11.6% of the children were exposed to screens before the age of 2 years and 34.5% exceeded the recommended daily screen time. A higher cumulative number of maternal ACEs was associated with a greater likelihood of both early onset of screen use and prolonged daily screen time, in a dose-response pattern. Specifically, children of mothers with four or more ACEs had increased odds of early screen exposure (OR = 3.871, 95% CI: 2.570–5.831) and prolonged daily screen time (OR = 2.022, 95% CI: 1.514–2.701). These associations remained consistent across various subgroups. However, child or maternal characteristics did not moderate these associations.

Conclusions Our study identified maternal ACEs as a potential risk factor associated with children's screen use habits. Further research is needed to develop interventions that support both ACE-exposed mothers and their children to reduce the risk of inappropriate screen use habits during early childhood.

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Highlights

- Approximately 11.6% of preschool children had screen exposure before age 2 and 34.5% exceeded the recommended daily screen time.
- Maternal adverse childhood experiences were linked to inappropriate screen use in preschool children.
- These associations remained consistent across various child and maternal characteristics.

Keywords Maternal adverse childhood experiences, Screen use, Intergenerational association, Moderation effect, Preschool children

Introduction

In modern parenting, screens like televisions, smartphones, and tablets are frequently used as tools for child entertainment and education. However, this practice raises concerns, such as early onset of screen exposure and prolonged daily screen time, both of which have been demonstrated to be detrimental to children's development and health, especially during early childhood [1, 2, 3, 4, 5]. Early childhood is a critical period for cognitive, emotional, and social development, during which the brain undergoes rapid growth and adaptation, enabling children to acquire new skills and interact with their environment [6]. Inappropriate screen use during this critical period can interrupt these developmental processes, with far-reaching consequences among children [7, 8, 9]. For instance, a cross-sectional study of preschool children has found that both early screen exposure and prolonged screen time were linked to higher risks of behavioral problems and poorer health-related quality of life [5]. Similarly, a longitudinal study has revealed that inappropriate screen use during preschool years had a negative impact on children's cognitive development [1]. These findings highlight the importance of identifying factors that contribute to these inappropriate screen use habits in young children.

Mothers play a crucial role in shaping the early experiences of their children. The ways in which mothers interact with their children, as well as their mental health status, have profound impacts on child development and well-being [10, 11]. In recent years, growing attention has been given to the intergenerational impacts of maternal adverse childhood experiences (ACEs) on child behavioral and health outcomes [12, 13, 14]. ACEs, which include various forms of abuse, neglect, and household dysfunction experienced before the age of 18, have been linked to long-term psychological distress, including anxiety and depression [15]. When ACE-exposed individuals become mothers, these negative emotions may compromise their ability to provide an emotionally supportive environment, potentially increasing the likelihood of behavioral problems and inappropriate screen use in their children [16, 17]. Furthermore, mothers experiencing these negative emotions may turn to the internet as a coping mechanism to manage their unmet emotional needs [18]. Given that parental screen habits can influence children's screen behaviors [19], children of mothers with a history of ACEs may be more susceptible to inappropriate screen use. Maternal ACEs have also been associated with disadvantaged socioeconomic status [20, 21]. Limited financial and social resources may reduce their children's opportunities to attend educational programs or outdoor activities. As a result, screens may serve as a convenient source of entertainment, potentially contributing to early and prolonged screen exposure in young children. Furthermore, research suggests that maternal exposure to ACEs was linked to heightened parental stress and negative parenting behaviors [22, 23], a known factor associated with increased daily screen time in children [24]. These findings collectively suggest a potential link between maternal ACEs and children's screen-related behaviors. However, direct investigations into maternal ACEs and child screen habits remain scarce, highlighting a critical research gap.

To address this, we conducted a cross-sectional study to explore whether experiences of maternal ACEs were associated with inappropriate screen use, including early screen exposure and prolonged daily screen time, in preschool-aged children primarily cared for by their mothers. By identifying these associations, the study seeks to contribute valuable insights that enhance our understanding of the early-life factors influencing children's screen use habits during critical developmental periods.

Materials and methods

Study design and participants

This cross-sectional study was conducted from May to July 2021 in Chengdu, a major city in western China, which includes 12 urban districts, 5 county-level cities, and 3 counties. A multi-stage sampling method was employed, starting with the random selection of four urban districts, two county-level cities, and one county. From each of these areas, two preschools were randomly chosen, resulting in a total of 14 preschools. All children and their parents from these preschools were invited to participate. During the recruitment period, caregivers of 5,102 children completed an online questionnaire, yielding an 86.5% response rate. We excluded 818 children whose questionnaires were completed by individuals other than their mothers. We also excluded 1102

children whose primary caregivers were fathers or other guardians, as our study focused on maternal influences on children's screen use behaviors, and primary caregivers were expected to have a more direct role in shaping these behaviors. Additionally, 41 children with inaccurate age and 10 with missing data on screen use were also excluded. After these exclusions, the final analysis included 3131 mother-child pairs.

Maternal ACEs

The Adverse Childhood Experiences-International Questionnaire (ACE-IQ), developed by the World Health Organization, was used to measure maternal ACEs [25]. This questionnaire, which has demonstrated good validity and reliability within the Chinese population [26], consists of 29 items addressing childhood adversities such as neglect, abuse, household challenges, and exposure to community and collective violence. Due to cultural sensitivities surrounding sexual abuse and the relative rarity of collective violence in China, eight items related to these categories were excluded from the survey. Consequently, the adapted questionnaire comprised 21 items covering 12 ACE categories: emotional abuse (2 items), physical abuse (2 items), emotional neglect (2 items), physical neglect (3 items), intimate partner violence (3 items), substance abuse in the household (1 item), incarceration of a household member (1 item), mental illness in the household (1 item), parental death (1 item), parental separation or divorce (1 item), bullying (1 item), and community violence (3 items). A detailed list of questionnaire items and criteria for defining positive responses for each item is provided in Supplementary Table 1. For ACE indicators with a single item, a positive response was coded as exposed (coded as 1) and a negative response as non-exposed (coded as 0), while for multi-item ACE indicators, a positive response to any item indicated exposure to that type of adversity. The cumulative ACE score was calculated by summing the 12 indicators, resulting in a total score ranging from 0 to 12. Based on these scores, mothers were categorized into five groups: 0, 1, 2, 3, and ≥4 ACEs [27, 28].

Children's screen use

Parents were asked to specify the age at which their children first used electronic devices, including computers, tablets, mobile phones, TVs, or e-readers. Based on these responses, children's initial screen exposure was categorized. Early screen exposure was defined as beginning using screen before the age of 2 years according to the 2021 Physical Activity Guidelines for Chinese [29]. Those who started using electronic devices at the age of 2 years or later were categorized as having later initiation of screen exposure. For daily screen time, parents reported the average hours their children spent on various electronic devices during a typical weekday and weekend. Average daily screen time was calculated using the formula: (5 × daily screen time on weekdays + 2 × daily screen time on weekends) / 7. In line with existing guideline [29], moderate daily screen time was defined as < 1 h/day for children aged 5 years or younger and < 2 h/day for children older than 5 years. Children exceeding these thresholds were classified as having prolonged daily screen use.

Covariates

Demographic details were provided by mothers for both themselves (age) and their children (age, gender, and single-child status). Single-child status was defined as having no siblings (yes) or having one or more siblings (no) in the family. We did not consider other demographic information or maternal emotional states, such as marital status, education levels, or depressive symptoms, as they may act as the mediating factors in the associations between maternal exposure to ACEs and children's screen use habits [30].

Statistical analysis

Child and maternal characteristics across groups defined by early onset of screen use and prolonged daily screen

Table 1 Child and maternal characteristics by early onset of screen use and prolonged daily screen time in preschool children

	Early onset of screen use		*P* value	Prolonged daily screen time		*P* value
	No	Yes		No	Yes	
	N = 2767	*N* = 364		*N* = 2050	*N* = 1081	
Child's age, mean (SD)	4.6 (1.0)	4.5 (1.0)	0.001	4.8 (1.0)	4.4 (0.8)	< 0.001
Gender, n (%)			0.316			0.356
Boy	1438 (52.0%)	179 (49.2%)		1071 (52.2%)	546 (50.5%)	
Girl	1329 (48.0%)	185 (50.8%)		979 (47.8%)	535 (49.5%)	
Single-child status, n (%)			0.845			0.629
No	1551 (56.1%)	206 (56.6%)		1144 (55.8%)	613 (56.7%)	
Yes	1216 (43.9%)	158 (43.4%)		906 (44.2%)	468 (43.3%)	
Maternal age, mean (SD)	33.4 (4.6)	33.5 (4.9)	0.647	33.7 (4.6)	32.7 (4.7)	< 0.001

Abbreviations: SD: standard deviation

time were compared using independent t-tests for continuous variables and χ^2 tests for categorical variables. To evaluate the associations between maternal cumulative ACE exposure and these two screen use behaviors in preschool children, univariable and multivariable logistic regression models were performed separately for each behavior. The multivariable models adjusted for both child characteristics (age, gender, and single-child status) and maternal age according to previous research [31]. Stratified analyses were performed to examine the consistency of these associations across different subgroups (children's age, gender, single-child status, and maternal age). Specifically, children's and maternal ages were categorized based on their median values, with children grouped into < 5 years and ≥ 5 years, and mothers into < 33 years and ≥ 33 years. Likelihood ratio tests were further performed to explore the potential moderating role of these factors in the associations between maternal ACE exposure and children's screen use behaviors.

To further validate our findings, we conducted a sensitivity analysis by treating age of screen use onset and daily screen time as continuous variables and re-evaluated their associations with maternal ACEs. Additionally, recognizing that mothers may still influence their children's screen use even when they are not the primary caregivers, we performed another sensitivity analysis by including the 1102 children whose primary caregivers were fathers or other guardians.

All statistical analyses were conducted using Stata software version 15.0, and a two-tailed *P*value of less than 0.05 was considered statistically significant.

Results

Our study included 3131 mother-child dyads, including 1617 boys (51.6%) and 1514 girls (48.4%). The mean ages for the children and their mothers were 4.6 (SD: 1.0) and 33.4 (SD: 4.6) years, respectively. Among the mothers, 470 (15.0%) reported no ACE exposure, 1423 (45.4%) had one ACE, 569 (18.2%) had two ACEs, 254 (8.1%) had three ACEs, and 415 (13.3%) reported exposure to four or more ACEs. Regarding children's screen use, approximately 11.6% ($N = 364$) were exposed to screens before the age of 2 years (Table 1). Compared to those who started using screens after the age of 2, children with early screen exposure were slightly younger on average. Additionally, 34.5% ($N = 1081$) of the children exceeded the recommended daily screen time guidelines. Compared to children with moderate daily screen time, those with prolonged daily screen exposure were younger and more likely to have younger mothers.

Figure 1 shows the prevalence of early onset of screen exposure and prolonged daily screen use in preschool children stratified by the number of maternal ACEs. The prevalence of both screen use behaviors increased as the number of maternal ACEs increased, indicating a dose-response pattern.

We further assessed the associations of maternal ACEs with screen use habits in preschool children (Table 2). Both crude and adjusted models showed a significant dose-response pattern, with a higher number of maternal ACEs associated with increased odds of early onset of screen use and prolonged daily screen time. Specifically, in the adjusted model, children of mothers with four or more ACEs had a significantly higher likelihood of early onset of screen use (OR = 3.871, 95% CI: 2.570–5.831) and prolonged daily screen time (OR = 2.022, 95% CI: 1.514–2.701) compared to children of mothers with no ACE exposure. In the sensitivity analysis treating age of screen use onset and daily screen time as continuous data, we observed that a higher number of maternal ACEs was associated with an earlier age of screen use onset and longer daily screen time, consistent with our main findings (Supplementary Table 2). In addition, the sensitivity analysis including children whose primary caregivers were fathers or other guardians also showed consistent results (Supplementary Table 3), further reinforcing the robustness of our findings.

The stratified analyses indicated consistent associations and trends between maternal ACEs and both early onset of screen use and prolonged daily screen time across various subgroups, including child age, gender, single-child status, and maternal age (Tables 3 and 4). However, these factors did not significantly modify such associations.

Discussion

Among preschool children primarily cared for by their mothers, we identified a dose-response pattern, where higher cumulative maternal exposure to ACEs was associated with increased likelihood of both early onset of screen use and prolonged daily screen exposure. This pattern persisted consistently across various subgroups, regardless of the child's age, gender, single-child status, or the mother's age. These findings highlight the importance of recognizing maternal ACEs as a potential risk factor influencing children's screen use habits.

Although no direct analogues were found in the literature, our results align with previous epidemiological studies linking maternal ACEs to adverse developmental and behavioral outcomes in children [13, 14, 32, 33, 34]. For example, one study conducted in Canada has found that maternal ACEs were associated with higher levels of behavior problems among their children at age 3, including internalizing issues such as anxiety, externalizing difficulties like aggression and hyperactivity, and temperament traits such as surgency and negative affectivity [33]. Another study conducted in Japan has demonstrated an association between maternal ACE exposure and lower self-rated academic performance

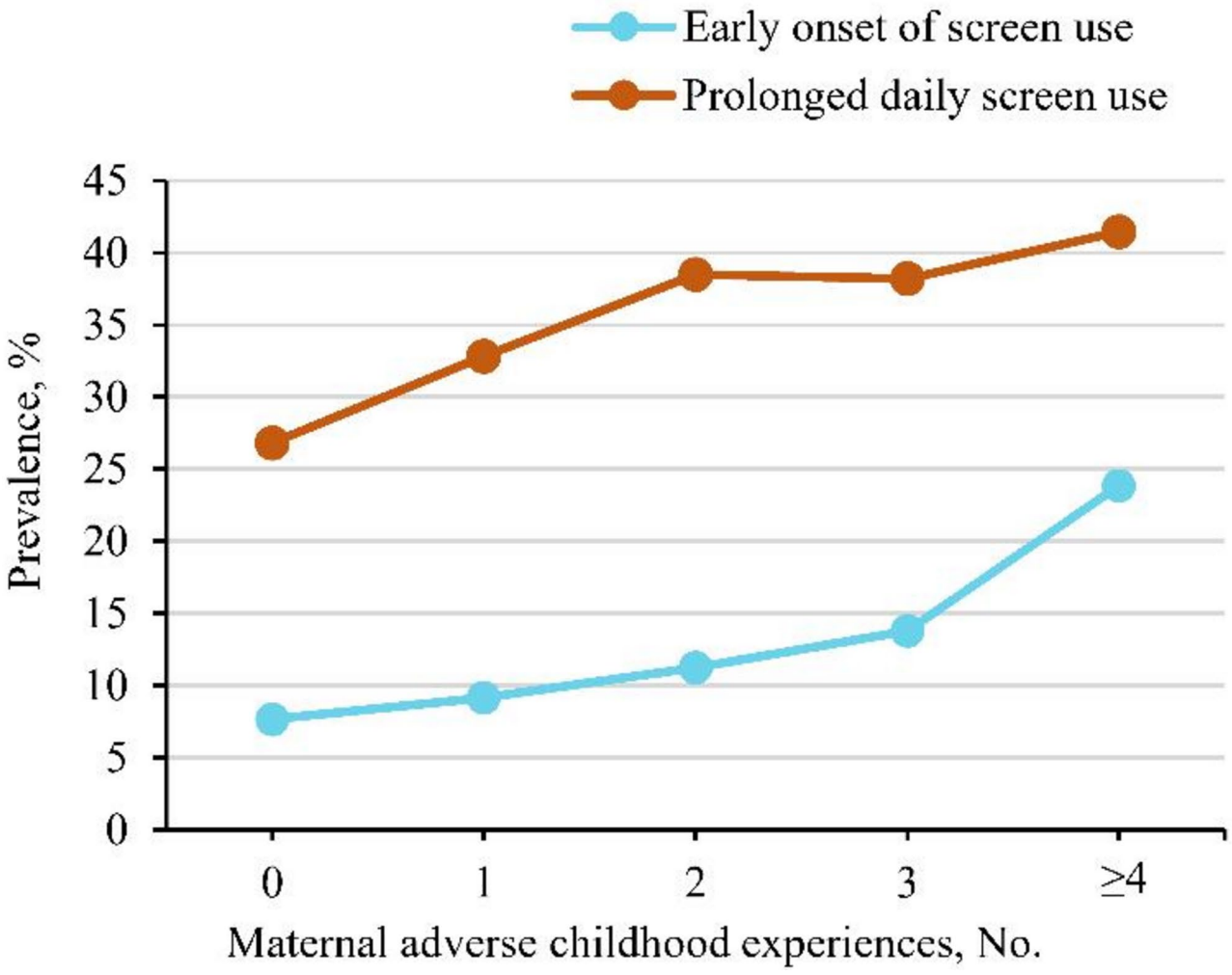

Fig. 1 Prevalence of early onset of screen use and prolonged daily screen time in preschool children, stratified by cumulative maternal ACEs

in their adolescent offspring [32]. Additionally, a recent meta-analysis has summarized 52 studies and indicated that parental ACEs were associated with increased risks of mental health problems, and both internalizing and externalizing difficulties in their children [34]. This meta-analysis also confirmed that sociodemographic factors, including the children's age, gender, and parental age, did not significantly moderate these associations [34]. The consistency of our results with existing epidemiological research highlights the potential role of maternal ACEs in shaping early childhood screen use patterns, independent of socioeconomic status.

The association between maternal ACEs and screen use habits in their preschool children can be explained through multiple pathways. First, ACEs are well-documented risk factors for poor mental health outcomes in adults, leading to elevated levels of anxiety and depression [15]. These psychological challenges can significantly impair a mother's emotional availability and stability, making it difficult to consistently respond to her child's needs [35]. As a result, mothers may unintentionally reinforce early and frequent screen exposure as a tool to manage the child's behavior, in order to provide a temporary escape or relief for both the mother and the child [36, 37]. Furthermore, mothers with ACE exposure often experience heightened parental stress and may adopt more permissive or inconsistent parenting styles [22, 23], which have been linked to increased daily screen time in children [24]. Second, mothers with ACE exposure often face socioeconomic challenges [20, 21], which may limit their ability to provide stimulating environments with alternative activities, such as outdoor play, educational programs, or organized recreational opportunities [38, 39]. In these resource-constrained settings, screens may become an easy and accessible form of entertainment for children, subsequently leading to early and prolonged screen exposure. Third, mothers who have experienced childhood adversity may rely heavily on screens to cope with their own emotional distress or stress [18]. Their children, in turn, may mirror these behaviors,

Table 2 Associations of maternal aces with early onset of screen use and prolonged daily screen time in preschool children

	Early onset of screen use		Prolonged daily screen time	
	OR (95%CI)	***p* value**	**OR (95%CI)**	***p* value**
Crude model				
No. of Maternal ACEs				
0	Ref	-	Ref	-
1	1.212 (0.825, 1.781)	0.327	1.334 (1.057, 1.682)	0.015
2	1.528 (0.996, 2.344)	0.052	1.708 (1.311, 2.226)	< 0.001
3	1.927 (1.177, 3.154)	0.009	1.687 (1.219, 2.335)	0.002
≥ 4	3.777 (2.511, 5.680)	< 0.001	1.932 (1.457, 2.563)	< 0.001
p value for trend	< 0.001		< 0.001	
Adjusted model[a]				
No. of Maternal ACEs				
0	Ref	-	Ref	-
1	1.208 (0.821, 1.777)	0.338	1.306 (1.030, 1.655)	0.027
2	1.517 (0.988, 2.330)	0.057	1.650 (1.259, 2.163)	< 0.001
3	1.901 (1.159, 3.117)	0.011	1.701 (1.218, 2.374)	0.002
≥ 4	3.871 (2.570, 5.831)	< 0.001	2.022 (1.514, 2.701)	< 0.001
p value for trend	< 0.001		< 0.001	

Abbreviations: ACEs: adverse childhood experiences; CI: confidence interval; OR: odds ratio

[a] Adjusted models were controlled for children's age, gender, single-child status, and maternal age

Table 3 Stratified analyses of the associations between maternal ACEs and early onset of screen use in preschool children

	OR (95% CI) by No. of maternal ACEs[a]					*p* value for trend	*p* value for interaction[b]
	0	**1**	**2**	**3**	**≥ 4**		
Subgroups							
Child age[c]							0.838
< 5 year	Ref	1.195 (0.693, 2.061)	1.735 (0.961, 3.133)	2.147 (1.085, 4.245)	4.112 (2.297, 7.360)	< 0.001	
≥ 5 year	Ref	1.223 (0.708, 2.113)	1.271 (0.676, 2.389)	1.693 (0.823, 3.483)	3.581 (2.011, 6.375)	< 0.001	
Child gender							0.569
Boys	Ref	1.330 (0.776, 2.281)	1.246 (0.662, 2.346)	2.010 (1.004, 4.026)	3.749 (2.092, 6.720)	< 0.001	
Girls	Ref	1.096 (0.629, 1.909)	1.803 (0.998, 3.260)	1.836 (0.906, 3.722)	4.114 (2.304, 7.345)	< 0.001	
Sing-child status							0.085
Yes	Ref	1.314 (0.736, 2.347)	1.319 (0.685, 2.540)	1.994 (0.980, 4.058)	2.697 (1.445, 5.035)	< 0.001	
No	Ref	1.148 (0.684, 1.928)	1.686 (0.954, 2.982)	1.755 (0.875, 3.519)	5.169 (2.993, 8.926)	< 0.001	
Maternal age[c]							0.853
< 33 year	Ref	1.343 (0.760, 2.376)	1.572 (0.836, 2.956)	1.600 (0.737, 3.477)	4.205 (2.292, 7.716)	< 0.001	
≥ 33 year	Ref	1.095 (0.647, 1.854)	1.507 (0.838, 2.712)	2.236 (1.172, 4.265)	3.718 (2.126, 6.504)	< 0.001	

Abbreviations: ACEs: adverse childhood experiences; CI: confidence interval; OR: odds ratio

[a] Adjusted models were controlled for children's age, gender, single-child status, and maternal age, except for the stratified variable in each subgroup

[b] *p* value for interaction was generated by likelihood ratio test

[c] Categorized by the median age

subsequently leading to early onset of screen use and prolonged screen time [19]. Therefore, we observed significant associations between maternal ACEs and both the early onset of screen use and prolonged daily screen time in preschool-aged children.

Our study benefited from a robust sample size of mother-child dyads, which enhanced the statistical power of our analyses. By exclusively including children whose primary caregivers were mothers, we ensured a consistent focus on maternal influences. By assessing both the onset of screen use and daily screen time, we captured a comprehensive view of how maternal ACEs impact their children's screen behaviors. However, several limitations of this study warrant further discussion. First, the reliance on mothers' reports for children's screen use may introduce inaccuracies, particularly for screen time that occurs outside of the mother's supervision, such as at school or under other caregivers' care. Additionally, mothers with ACE exposure may perceive or evaluate their children's screen use more negatively, potentially leading to reporting bias. Future research should consider objective measures, such as digital tracking or observational data, to achieve a more accurate assessment of children's screen behaviors. Second, while previous research has

Table 4 Stratified analyses of the associations between maternal aces and prolonged daily screen time in preschool children

	OR (95% CI) by No. of maternal ACEs[a]					*p* value for trend	*p* value for interaction[b]
	0	1	2	3	≥ 4		
Subgroups							
Child age[c]							0.179
< 5 year	Ref	1.253 (0.905, 1.734)	1.450 (0.998, 2.105)	1.453 (0.914, 2.311)	1.466 (0.973, 2.211)	0.050	
≥ 5 year	Ref	1.306 (0.926, 1.841)	1.874 (1.271, 2.762)	2.068 (1.292, 3.309)	2.558 (1.711, 3.825)	< 0.001	
Child gender							0.302
Boys	Ref	1.120 (0.811, 1.548)	1.734 (1.194, 2.518)	1.510 (0.951, 2.397)	1.753 (1.171, 2.625)	< 0.001	
Girls	Ref	1.539 (1.084, 2.183)	1.584 (1.068, 2.352)	1.909 (1.176, 3.098)	2.320 (1.527, 3.525)	< 0.001	
Sing-child status							0.484
Yes	Ref	1.287 (0.893, 1.854)	1.589 (1.051, 2.402)	1.378 (0.837, 2.266)	2.218 (1.444, 3.407)	< 0.001	
No	Ref	1.309 (0.958, 1.790)	1.729 (1.206, 2.478)	2.078 (1.320, 3.273)	1.895 (1.276, 2.814)	< 0.001	
Maternal age[c]							0.712
< 33 year	Ref	1.160 (0.830, 1.620)	1.601 (1.095, 2.341)	1.522 (0.936, 2.473)	1.919 (1.274, 2.891)	< 0.001	
≥ 33 year	Ref	1.493 (1.065, 2.092)	1.756 (1.191, 2.588)	1.881 (1.186, 2.984)	2.205 (1.460, 3.330)	< 0.001	

Abbreviations: ACEs: adverse childhood experiences; CI: confidence interval; OR: odds ratio

[a] Adjusted models were controlled for children's age, gender, single-child status, and maternal age, except for the stratified variable in each subgroup

[b] *p* value for interaction was generated by likelihood ratio test

[c] Categorized by the median age

highlighted that certain educational or developmentally enriching screen contents can positively affect children's learning and cognitive development [40, 41], our study was unable to account for the type or quality of screen contents due to a lack of available information. Future research could further differentiate between educational and non-educational contents to provide more nuanced insights into the impact of maternal ACEs on screen use habits. Third, although we assessed several maternal ACE items, we did not capture detailed information on their severity, intensity, duration, or mothers' perceptions of these experiences, all of which could influence the associations discussed [42, 43]. In addition, while sexual abuse was not included in our study due to cultural sensitivities, it is important to acknowledge its potential intergenerational impact, which should be thoroughly examined in future research. Fourth, our study sample was drawn from a single megacity in China during the COVID-19 pandemic. This raises concerns about the sample's representativeness and the generalizability of our findings to other populations in the post-pandemic period. Future research should include more diverse populations in the post-pandemic period to enhance the external validity of the results. Finally, although we have discussed several possible mechanisms to contextualize the association between maternal ACEs and children's screen use habits, the cross-sectional design precludes a conclusive examination of these pathways. Future longitudinal studies are needed to further elucidate how maternal ACEs influence their children's screen use behaviors through specific mediators, such as maternal screen use habits [19].

In conclusion, our study suggests an intergenerational association between maternal ACEs and screen use habits in their preschool offspring, consistent with previous research that highlights the negative impact of maternal ACEs on children's behaviors. Notably, we observed a dose-response pattern, where a higher number of maternal ACEs was linked to greater odds of inappropriate screen use in preschool children. These findings underscore the need for targeted support for both mothers and children. For mothers with ACE exposure, addressing their emotional and psychosocial needs and enhancing parenting practices through trauma-informed care may play a crucial role in reducing inappropriate screen use in their children. In turn, for children of mothers with experiences of ACEs, fostering supportive environments that promote healthy developmental opportunities may help mitigate the intergenerational impacts of adversity and encourage healthier screen use behaviors during early childhood. Nevertheless, further randomized controlled trials are needed to confirm these findings.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12889-025-22994-9.

Supplementary Material 1

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Author contributions

Y.Z carried out the initial analyses, drafted the initial manuscript, and reviewed and revised the manuscript; S.L. carried out the initial analyses and reviewed and revised the manuscript; W.C. conceptualized the study and reviewed and revised the manuscript; C.L. conceptualized and designed the study and reviewed and revised the manuscript; Y.R. and Y.Z. collected the data and reviewed and revised the manuscript; V.Y.G. carried out the initial

analyses, drafted the initial manuscript, conceptualized and designed the study, coordinated and supervised the study, and reviewed and revised the manuscript. All authors approved the final manuscript as submitted and agreed to be accountable for all aspects of the work.

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Data availability
The datasets used and analyzed during the current study are not publicly available for ethical and privacy reasons but are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
The study was conducted in accordance with the 1964 Declaration of Helsinki and its later amendments. Ethical approval was obtained from the Ethics Committee of the School of Public Health, Sun Yat-sen University (Ethical approval number: 2021[116]). After the intention and procedure of this study had been fully explained in detail, each parent has signed an informed consent before attending this study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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