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The impact of parental migration on screen exposure among children aged 1–66 months in rural China

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Abstract

Background Screen exposure, particularly recreational screen exposure, is an integral part of children's lives. However, little is known about how family factors influence children's excessive screen exposure, especially in the context of 69 million left-behind children experiencing parent–child separation in China. This study mainly concentrates on the correlation between parental migration, type of caregiver, depression and disciplinary practices of the caregiver and children's screen exposure, including average daily screen time (on weekdays or weekends) and screen content (recreational activities or learning activities).

Methods For a cross-sectional study, we collected data of family basic features, parental migration status and children's screen use in the past week from caregivers of 1,592 children aged 1–66 months in Anhui province. Children were classified into left-behind children (LBC), previously left-behind children (PLBC) and never left-behind children (NLBC) based on their parental migration. Multiple linear regression and binary logistic regression were used to identified the association between family factors and children's screen exposure.

Results Overall, PLBC had higher rates of screen exposure, as well as higher average daily exposure times, than NLBC and LBC. The results of logistic regression showed that PLBC had a higher likelihood of excessive screen use compared to NLBC (60 min/day, $OR = 1.40$, $p < 0.05$; 120 min/day, $OR = 1.76$, $p < 0.05$). The higher the score of disciplinary practices, the less time children spent on screens for entertainment ($B = -3.37$, $p < 0.01$).

Conclusions Our findings provide insights into the risks of children's screen exposure in different contexts of parental migration. The study emphasizes the urgent need to pay attention to PLBC's screen use and to strengthen caregivers' discipline and supervision over children's screen exposure.

Keywords Screen time, Screen exposure, Parental migration, Disciplinary practices, Left-behind children

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Background

In recent years, with the iterative upgrade of emerging technologies and the explosive growth of electronic devices, electronic media has become an inseparable part of life, which has greatly increased the probability of children's exposure to electronic screens. Meanwhile, the definition of screen exposure has also undergone changes. Previous studies have defined it as "watching or using anything with a screen, including televisions, DVDs, mobile devices, video games, and computers" [1]. As times passes, screen exposure is more accurately defined as "time spent in front of devices with screens such as televisions, computers, tablets or smartphones" [2]. Research has shown that the average daily screen exposure time of children and teenagers aged 5 to 18 is about 3.6 h and more than half exceeding the daily screen time guideline of two hours [3]. Furthermore, according to a survey of six provinces and cities in China, 58.3% of primary and secondary school kids aged 6 to 18 spend more than two hours per day on screens [4].

Existing research mainly focused on the effects of screen time on teenagers aged 6 to 18. These studies indicated a substantial link between teenagers' screen time and a reduction in sleep duration, as well as an increase in sleep issues [5]. Additionally, excessive screen time can lead to reduced offline engagement among youths [6], adversely affecting their mental health [7]. Especially for teenagers who were overly exposed to entertainment screens, they have poorer connections with their parents [8]. Not only that, a cross-sectional study focusing on children aged 2–5 also indicated that children who spent excessive time on screens might have problematic relationships with their mothers, manifested in low maternal acceptance and high neglect scores towards their children [9]. As the age of children's first contact with screens is getting younger, the debate over children's screen use is fierce. However, there were few studies on the harm caused by screen time for children from 0 to 6 years of age. These studies only showed the potential harm of screen time faced by children, including elevated weight from sedentary behavior [10] and impaired cognitive development [11]. At present, it is report that as total screen time increases, children's abilities in communication, problem-solving and personal socialization decrease [12]. Furthermore, it may lead to inattention and even attention deficit hyperactivity disorder (ADHD) [13].

Based on numerous research reports on children's screen time, the World Health Organization (WHO) called on parents to follow age-based child health guidelines to reduce the amount of time spent sitting in front of screens [14]. Later, the American Academy of Pediatrics (AAP) also proposed "Media Use Guidelines for Families" and "Family Media Plan" to encourage parents to limit children's screen time and cultivate good family media usage habits [15, 16]. According to the 2013 American Academy of Pediatrics (AAP) guidelines, children younger than two years old should not spend any time using electronic media, while children over two years old should be limited to less than 120 min/day [17]. The AAP released new media use guidelines in 2016, which mentioned that children under two years old should not engage in electronic media at all and children aged 2 to 5 should be limited to less than 60 min/day [18]. However, a considerable proportion of young children all around the world exceeded the recommended exposure times [19]. Numerous studies were not merely examining screen time, but also delving into the content of screen usage. Studies have shown that moderate learning screen exposure may help improve children's learning efficiency and practical skills. However, excessive entertainment screen exposure interacting with lower levels of physical activity can increase children's psychological distress, leading to problems such as inattention and declining academic performance [20]. In light of this evidence, screen exposure in early childhood cannot be ignored.

Extensive studies reported that various demographic factors of families were associated with children's screen exposure. Research by Çaylan et al. showed that maternal age of <30 years and maternal educational level of ≤ 12 years were associated with an increased risk of having a high problematic screen exposure [21]. Children whose parents have low levels of education were more prone to excessive screen exposure. Conversely, the higher the maternal authority score, the less screen exposure time their children have [22]. Parental unemployment and their excessive use of screens lead to children being overexposed to screen. Likewise, the age of the child and the presence of siblings were also risk factors for excessive screen exposure in children [23, 24]. Given that the time spent on electronic devices occurs within the home environment, parents or other caregivers play a key role in children's screen exposure habits [25]. Parental limits on screen time can effectively reduce children's viewing time of TV/video/DVD [26–28]. Additionally, a study in Singapore reported that parents who understood screen time recommendations influence their children's behaviors, with children spending less time in front of screens [29]. On the basis of these reported studies, we have to admit that children's screen time is inseparable from authoritative and disciplined parenting. However, numerous studies examining the effects of parental migration on children primarily concentrated on aspects such as mental health [30], growth [31] and skill development [32], neglecting the issue of excessive screen exposure stemming from a lack of parental

guidance or discipline. In terms of disciplinary practices, more research emphasized its impact on early childhood development [33], especially harsh disciplinary practices that caused physical injury, negative mental health and externalizing behaviors in children [34, 35]. Only a small number of studies exist regarding the impact of screen use on children. There were more studies on the impact of the depressive caregivers on children's depression and adverse educational outcomes. Instead, it not focused on its impact on children's excessive screen use [36, 37].

In recent years, with the rapid development of urbanization and industrialization in China, the characteristics of urban–rural mobility have become more and more obvious, as a large number of rural workers move to cities in search of higher-paying jobs to improve their family's economic conditions. Therefore, children are forced to stay in their hometown and be cared for by the elderly, typically grandmothers [38, 39]. Those children, who live in the original residence without their parents when one or both parents migrate, are called "left-behind children" (LBC). According to data from the 2020 National Census, the figure for LBC in China stood at 66.93 million in 2020, of which 41.77 million (62.4%) were in rural areas. By one estimate, there were 14.93 million rural left-behind children from 0 to 5 years of age, accounting for 37.5% of all rural left-behind children [40]. Given that the large number of parents who have migrated, the screen exposure problem of those left-behind children deserved special attention.

In view of this, the aims of this study were: first, to investigate how different forms of parental migration affect screen time and excessive screen exposure of children aged 1–66 months, including children whose one or both parents work outside the hometown currently (LBC), children whose one or both parents have been outside the hometown (PLBC) and children who have never been left behind (NLBC). Secondly, to explore the relationship between disciplinary practices, primary caregiver (mother vs. non-mother), caregiver's mental health (normal vs. depressed) and excessive screen use.

Materials and methods

Participants

From July to October 2023, we conducted a cross-sectional survey in Anhui Province, located in southeastern China. This province has a significant population outflow, with approximately 11.52 million people (18.9% of the resident population) moving to the more economically developed regions. For the convenience of sampling, we chose regions within the province that have high numbers of both migrant workers and left-behind children. Consequently, we selected children aged 1–66 months in Nanling County as the primary participants. Based on a study with a screen exposure rate of 58.3% [4], we set the minimum sample size to 1191. This allowed for 80% power to detect a ± 2% margin of difference, with a two-sided type I error rate of 0.05, according to the sample size formula for comparing multiple proportions [41]. Considering the rejection rate and invalid questionnaire, it was necessary to increase the sample size by 20%, so the final sample size should be more than 1429.

In our study, participating children were divided into two age groups: 1–36 months and 37–66 months. First of all, our sampling scope covered all eight townships under the jurisdiction of Nanling County. We selected a community health center and nine township health centers with ten vaccination sites for research. Since the vaccination rate of China's immunization program for children is close to or exceeded 99% and the stage of vaccination primarily concentrates on the period prior to 36 months [42]. Professionally trained volunteers assisted children's parents or other caregivers to fill out questionnaires. Secondly, with the help of the local education bureau, we selected one or two kindergartens with a large number of kids in each of the eight towns, 14 in total. All parents entered the survey system through the questionnaire link (wenjuanxing, Chinese version of SurveyMonkey) issued by the teacher. The receipt form was brought back by the child after the parent signed it to ensure a high participation rate, so participants could basically cover children aged 37–66 months. The age criteria for entering kindergartens in China was children aged 36–72 months. Due to the limitations of the scale, we only sampled children with a maximum age of 66 months. Prior to the survey, all participants and their parents/guardians granted written consent. The confidentiality of the questionnaire was strictly guaranteed as only the researchers had access to the questionnaire information.

Measures

Socio-demographic variables

Based on existing literature, we have included some relevant socio-demographic characteristics: age (monthly), gender (male/female), only child (yes/no), maternal age at childbirth (≤ 25/ > 25), family monthly income (≤ 5999/6000–8999/9000–11999/ ≥ 12,000 RMB), parental highest education level (middle school and lower/high school/college and above), parental marital status (married/other), parental working status (employed/other), primary caregiver (mother/grandmother/other) [43].

Parental migration status

According to the two questions mentioned "Since the child was born, has the child's father/mother left the county to work or do business? (more than six months)" [30] to determine the type of children included in the

survey. The options included "yes, currently migrates", "yes, previously migrated", "no, never migrates" and "Other (divorce, death)". Based on the answers, we divided the children into the following three groups: (1) for LBC, one or both parents were currently migrating; (2) for PLBC, one or both parents previously migrated but now living at home; (3) for NLBC, both parents lived at home and neither had ever migrated elsewhere for work. Considering the impact of different forms of parental absence on children, which was different from parental migration, samples of parents who have divorced or passed away were excluded.

Caregiver's depression

Data on caregiver's depression in the last two weeks were collected via the Beck Depression Inventory-II (BDI-II), which is one of the most widely used self-assessment scales for depressive symptoms. BDI-II consists of 21 entries on a scale of 0 to 3, with the sum of the 21 entry scores being the total scale score, which ranges from 0 to 63. According to the demarcation scores provided by the original scale, a total score of 0–13 is considered as "no depression", 14–19 as "mild depression", 20–28 as "moderate depression" and 29–63 as "severe depression" [44]. In this study, Cronbach's alpha coefficient is 0.90.

Disciplinary practices

Based on previous research [33, 45, 46], we used these five questions to measure disciplinary practices: Q1. When disciplining your baby, do you raise your voice or yell? Q2. When disciplining your baby, do you spank your baby? Q3. When disciplining your baby, do you take away toys or other things your baby wants? Q4. When disciplining your baby, do you use a time limit to terminate what your baby is doing? Q5. When disciplining your baby, do you explain to your baby why his behavior is inappropriate? Based on existing classification of disciplinary practices [47], we classified Q1/Q2/Q3 as harsh disciplinary practices and Q4/Q5 as positive disciplinary practices. We used a binary choice scale, where a "yes" response in the positive discipline was scored as 1 and a "no" response was scored as 0. A "no" response in the harsh disciplinary was scored as 1 and a "yes" response was scored as 0. Adding up the two scores, which ranged from 0 to 5 points. The higher the score, the more positive the disciplinary practices.

Screen exposure

Information on children's screen exposure was obtained by having caregivers complete the following questions: Please recall whether the child has used electronic products for entertainment activities/learning activities in the past week? If the answer is "Yes", then continue to answer. Please fill in the average daily time (minutes) spent on various electronic products for entertainment activities (watching cartoons and short videos, playing games, etc.) /learning activities (early childhood education classes, etc.) from Monday to Friday. Please fill in the average daily time (minutes) spent on various electronic products for entertainment activities/learning activities on weekends [48, 49]. Parental reports are commonly used in the existing literature to assess children's use of electronic screen devices [50]. On this basis, we weighted the average of weekdays and weekends screen time using the following formula: average screen time = (average screen time per day on weekdays × 5 + average screen time per day on weekends × 2)/7 [51].

Excessive screen exposure: The 2013 American Academy of Pediatrics (AAP) guidelines mentioned that children under two years old should not be exposed to any electronic screens, while children over two years old should be limited to less than 120 min/day [17]. The new guidelines of AAP released in 2016 lowered this time standard to 60 min/day [18]. We included both classifications in our study as a way to explore differences in early screen exposure among children with different parental migration status.

Statistical analysis

First, we conducted a normality test on screen time. Since all showed non-normal distributions, the multiple sample rank-sum test (for quantitative variable) and the chi-square test (for categorical variable) were applied to compare the socio-demographic characteristics of the three groups of children with different parental absence statuses and differences in screen exposure. Multiple linear regression models were used to examine the relationship between screen time use and parental migration. Using binary logistic regression models to investigate the effect of parental migration on screen exposure. These models were adjusted for sample characteristics (age, gender, only child, maternal age at childbirth, monthly household income, parental highest education level, parental marital status, parental working status, primary caregiver, caregiver's depression). All data were entered by two people through Epidata 3.1 version and processed using SPSS 26.0 version. The alpha level was established at 0.05 and all the tests were two-sided.

Results

We received responses from almost 1592 child caregivers: 578 current-LBC (LBC), 234 previous-LBC (PLBC), 780 never-LBC (NLBC). Table 1 presents descriptive statistics for the three groups of children classified according to parental migration status. According to the overall results, there was no statistically significant

Table 1 Socio-demographic characteristics of different types of children, Mean (SD)/n (%)

Variables	LBC *n* = 578①	PLBC *n* = 234②	NLBC *n* = 780③	K-W or χ^2	*P*-Value
Age (months)[a], Mean (SD)	45.6 (14.5)	46.2 (15.8)	42.2 (17.3)	14.85	0.001
Gender of children, n (%)				5.46	0.065
Male	280 (48.4)	130 (55.6)	422 (54.1)		
Female	298 (51.6)	104 (44.4)	358 (45.9)		
Only child, n (%)				3.98	0.137
Yes	241 (41.7)	84 (35.9)	288 (36.9)		
No	337 (58.3)	150 (64.1)	492 (63.1)		
Maternal age at childbirth (years), n (%)				2.19	0.334
≤ 25	124 (21.5)	50 (21.4)	144 (18.5)		
> 25	454 (78.5)	184 (78.6)	636 (81.5)		
Monthly household income (RMB*)[b], n (%)				14.91	0.021
≤ 5999	105 (18.2)	63 (27.2)	190 (24.4)		
6000–8999	158 (27.3)	55 (23.7)	207 (26.6)		
9000–11999	124 (21.5)	55 (23.7)	172 (22.1)		
≥ 12,000	191 (33.0)	59 (25.4)	210 (27.0)		
Parental highest education level[c], n (%)				29.99	< 0.001
Middle school and lower	178 (30.8)	77 (32.9)	164 (21.0)		
High school	150 (26.0)	52 (22.2)	181 (23.2)		
College and above	249 (43.2)	105 (44.9)	435 (55.8)		
Parental marital status, n (%)				0.28	0.869
Married	541 (93.6)	219 (93.6)	735 (94.2)		
Other	37 (6.4)	15 (6.4)	45 (5.8)		
Parental current work status[d], n (%)				13.41	0.001
Employed	548 (94.8)	206 (88.0)	704 (90.3)		
Other	30 (5.2)	28 (12.0)	76 (9.7)		
Primary caregiver[e], n (%)				55.31	< 0.001
Mother	337 (58.3)	167 (71.4)	597 (76.5)		
Grandmother	214 (37.0)	58 (24.8)	152 (19.5)		
Other	27 (4.7)	9 (3.8)	31 (4.0)		
Caregiver's depression, n (%)				1.51	0.471
Yes (scores > 13)	102 (17.6)	45 (19.2)	125 (16.0)		
No (scores ≤ 13)	476 (82.4)	189 (80.8)	655 (84.0)		

LBC left-behind children, *PLBC* previously left-behind children, *NLBC* never left-behind children

[a] : *n* = 1592, Post-hoc, (1,3), (2,3)

[b] : *n* = 1589, Post-hoc, (1,2), (1,3)

[c] : *n* = 1591, Post-hoc, (1,3), (2,3)

[d] : *n* = 1592, Post-hoc, (1,2), (1,3)

[e] : *n* = 1592, Post-hoc (1,2), (1,3)

[*] : $1 = ¥7.28 (Average USD/RMB exchange rate in October 2023)

disparity observed in terms of gender, siblings, maternal age at childbirth, parental marital status and caregiver's depression. PLBC was somewhat older on average (mean 46.2 months, SD 15.8 months) than LBC and NLBC. In general, compared with PLBC and NLBC, the LBC had a higher proportion of working parents (94.8%) and family monthly income ≥ 12,000 RMB. However, the proportion of parents in the NLBC group whose highest educational level was college or above (55.8%) was higher than that in the other two groups. Nearly, 37% of LBC were primarily cared by grandparents, whereas the proportions for PLBC and NLBC were roughly one-quarter and one-fifth, respectively. The proportion of PLBC (64.1%) and NLBC (63.1%) having siblings was higher than LBC (58.3%). The parental married status of LBC and PLBC was slightly lower than that in the NLBC group.

The differences in screen time between the three groups of children using electronic products for entertainment/learning activities at different time periods are displayed in Table 2. Statistically significant distinctions were evident among the three groups of children in terms of average daily screen time for entertainment

Table 2 Screen exposure for different types of children in the last week, Mean (SD)/n (%)

Variables	LBC①	PLBC②	NLBC③	K-W or χ^2	*P*-Value
Whether or not they use electronic devices for recreational activities, *n* = 1290				3.78	0.151
Yes, *n* = 1204	458 (93.9)	173 (90.1)	573 (93.9)		
No, *n* = 86	30 (6.1)	19 (9.9)	37 (6.1)		
Average time spent using electronics for recreational activities per day during the week/min, *n* = 1204	48.75 (41.86)	52.35 (38.72)	47.16 (41.85)	5.15	0.076
Average daily time spent using electronics for recreational activities on weekdays/min[a], *n* = 1204	42.43 (41.27)	45.92 (35.53)	42.21 (44.25)	6.22	0.045
Average daily time spent using electronics for recreational activities on weekends/min, *n* = 1204	64.55 (55.24)	68.42 (58.61)	59.52 (51.13)	2.95	0.229
Whether or not they use electronic devices for learning activities, *n* = 1290				2.74	0.254
Yes, *n* = 743	271 (55.5)	120 (62.5)	352 (57.7)		
No, *n* = 547	217 (44.5)	72 (37.5)	258 (42.3)		
Average time spent using electronics for learning activities per day during the week/min[b], *n* = 743	32.05 (30.50)	41.35 (38.82)	30.95 (29.80)	7.29	0.026
Average daily time spent using electronic devices for learning activities on weekdays/min[c], *n* = 743	29.60 (31.84)	38.50 (41.00)	29.03 (33.85)	7.19	0.027
Average daily time spent using electronics for learning activities on weekends/min, *n* = 743	38.17 (36.07)	48.46 (45.72)	35.74 (31.01)	5.27	0.072
Screen exposure (average day of the week)[d], *n* = 1290				6.18	0.045
Yes, ≥ 60 min/d*	219 (44.9)	105 (54.7)	275 (45.1)		
No, < 60 min/d	269 (55.1)	87 (45.3)	335 (54.9)		
Screen exposure (average day on weekdays)				3.26	0.196
Yes, ≥ 60 min/d	211 (43.2)	95 (49.5)	257 (42.1)		
No, < 60 min/d	277 (56.8)	97 (50.5)	353 (57.9)		
Screen exposure (average day on weekends)				0.23	0.891
Yes, ≥ 60 min/d	302 (61.9)	122 (63.5)	376 (61.6)		
No, < 60 min/d	186 (38.1)	70 (36.5)	234 (38.4)		
Screen exposure (average day of the week)[e], *n* = 1290				6.96	0.031
Yes, ≥ 120 min/d#	70 (14.3)	37 (19.3)	72 (11.8)		
No, < 120 min/d	418 (85.7)	155 (80.7)	538 (88.2)		
Screen exposure (average day on weekdays)[f]				8.28	0.016
Yes, ≥ 120 min/d	66 (13.5)	38 (19.8)	71 (11.6)		
No, < 120 min/d	422 (86.5)	154 (80.2)	539 (88.4)		
Screen exposure (average day on weekends)				3.67	0.160
Yes, ≥ 120 min/d	134 (27.5)	63 (32.8)	157 (25.7)		
No, < 120 min/d	354 (72.5)	129 (67.2)	453 (74.3)		

[a] : Post-hoc, (2,3)

[b] : Post-hoc, (1,2), (2,3)

[c] : Post-hoc, (1,2), (2,3)

[d] : Post-hoc, (1,2), (2,3)

[e] : Post-hoc, (2,3)

[f]: Post-hoc, (1,2), (2,3)

* : The screen guidelines published by the American Academy of Pediatrics in 2016 concluded that limitations need to be placed on screen time to no more than 1 h/day for children aged 2–5 years

: The screen guidelines published by the American Academy of Pediatrics in 2013 state that screen time for children aged 2 years and older should be no more than 1–2 h/day

min/d: minutes per day

and learning activities in the past week on weekdays and average daily screen time for learning activities in the past week. Using 60 min/d as the standard for screen exposure, there was a significant difference in whether the average daily screen time of the three groups of children in the past week exceeded the guideline recommendations ($\chi^2 = 6.18$, $p < 0.05$). Nonetheless, setting 120 min/d as the threshold for screen exposure, there were significant differences among the three groups of children in whether their screen time exceeded the guideline recommendations on average day of the past week and average day on weekdays ($\chi^2 = 6.96$, $p < 0.05$; $\chi^2 = 8.28$, $p < 0.05$).

Table 3 provides information on the binary logistic regression of whether electronic devices are used for entertainment or study, as well as the multiple linear regression of screen use time results over different time periods. In the unadjusted model, compared with the NLBC group, PLBC ($B = 9.74$, 95%CI [3.26, 16.21], $p < 0.01$; $B = 8.79$, 95%CI [1.74, 15.84], $p < 0.05$; $B = 12.11$, 95%CI [4.79, 19.43], $p < 0.01$) had more daily screen time exposure to learning activities (whether on weekdays,

Table 3 Regression analysis for electronic device usage by different types of children with adjustment for socio-demographic characteristics, B/OR (95%CI)

	Whether or not they use electronic devices for recreational activities[a], $n = 1290$		Average time spent using electronics for recreational activities per day during the week/min[b], $n = 1204$		Average daily time spent using electronics for recreational activities on weekdays/min[c], $n = 1204$		Average daily time spent using electronics for recreational activities on weekends/min[d], $n = 1204$	
	model1	model2	model1	model2	model1	model2	model1	model2
Parental migration status (ref: NLBC)								
LBC	1.02 (0.62, 1.67)	1.18 (0.70, 1.98)	1.63 (-3.47, 6.72)	1.11 (-4.15, 6.37)	0.31 (-4.85, 5.47)	0.11 (-5.22, 5.43)	4.91 (-1.71, 11.54)	3.61 (-3.21, 10.43)
PLBC	1.71 (0.96, 3.05)	2.10 (1.15, 3.84)*	4.80 (-2.26, 11.87)	5.39 (-1.72, 12.51)	3.28 (-3.87, 10.44)	4.49 (-2.71, 11.69)	8.61 (-0.58, 17.79)	7.66 (-1.56, 16.87)
Primary caregiver (ref: Mother)								
Grandmother		0.43 (0.23, 0.80)**		1.51 (-4.00, 7.01)		0.43 (-5.15, 6.00)		4.21 (-2.92, 11.34)
Other		0.64 (0.19, 2.14)		6.03 (-4.97, 17.04)		4.51 (-6.64, 15.65)		9.85 (-4.41, 24.12)
Depression in caregiver (ref: No)								
Yes		0.58 (0.29, 1.17)		3.44 (-2.74, 9.62)		3.66 (-2.60, 9.92)		2.89 (-5.12, 10.90)
Score of disciplinary practices		1.09 (0.87, 1.38)		-3.37 (-5.82, -0.93)**		-2.68 (-5.16, -0.20)*		-5.09 (-8.26, -1.93)**
	Whether or not they use electronic devices for learning activities[e], $n = 1290$		Average time spent using electronics for learning activities per day during the week/min[f], $n = 743$		Average daily time spent using electronic devices for learning activities on weekdays/min[g], $n = 743$		Average daily time spent using electronics for learning activities on weekends/min[h], $n = 743$	
	model1	model2	model1	model2	model1	model2	model1	model2
Parental migration status (ref: NLBC)								
LBC	1.10 (0.86, 1.39)	1.09 (0.85, 1.41)	0.55 (-4.39, 5.49)	1.03 (-3.99, 6.05)	0.01 (-5.37, 5.39)	0.97 (-4.51, 6.46)	1.90 (-3.69, 7.48)	1.17 (-4.52, 6.86)
PLBC	0.83 (0.59, 1.15)	0.87 (0.61, 1.22)	9.74 (3.26, 16.21)**	10.05 (3.62, 16.48)**	8.79 (1.74, 15.84)*	9.42 (2.40, 16.43)**	12.11 (4.79, 19.43)**	11.63 (4.35, 18.91)**
Primary caregiver (ref: Mother)								
Grandmother		1.27 (0.97, 1.66)		-2.21 (-7.53, 3.12)		-3.58 (-9.39, 2.23)		1.23 (-4.81, 7.26)
Other		0.91 (0.53, 1.58)		-6.49 (-16.62, 3.65)		-6.35 (-17.41, 4.72)		-6.83 (-18.31, 4.65)
Depression in caregiver (ref: No)								
Yes		1.07 (0.79, 1.46)		10.07 (4.07, 16.08)**		10.66 (4.11, 17.22)**		8.60 (1.80, 15.40)*
Score of disciplinary practices		0.93 (0.82, 1.04)		-1.42 (-3.73, 0.89)		-1.27 (-3.79, 1.25)		-1.79 (-4.41, 0.83)

weekends or the past week). This result retained its significance even after making adjustments for socio-demographic variables. Furthermore, the adjusted model results also showed that PLBC were more likely to expose to electronic screens for entertainment ($OR = 2.10$, 95%CI [1.15, 3.84], $p < 0.05$). There was a significant negative correlation between the score of disciplinary practices and average daily screen time exposure to recreational activities (whether on weekdays, weekends or the past week). The higher the score of disciplinary practices, the less screen time children spent for entertainment ($B = -3.37$, 95%CI [-5.82, -0.93], $p < 0.01$; $B = -2.68$, 95%CI [-5.16, -0.20], $p < 0.05$; $B = -5.09$, 95%CI [-8.26, -1.93], $p < 0.01$). In addition, children whose caregivers were depressed spent more screen time on learning activities than those whose caregivers were mentally normal.

Similarly, Table 4 summarizes the binary logistic regression results for excessive screen exposure under different screen exposure standard settings. In both the initial model and adjusted model, compared with NLBC, PLBC was more likely to have an average daily screen exposure time greater than 60 min in the past week ($OR = 1.47$, 95%CI [1.05, 2.02], $p < 0.05$; 1.40, [1.00, 1.96], $p < 0.05$); At the same time, there was every probability that PLBC had an average daily screen exposure time more than 120 min last week (1.74, [1.12, 2.69], $p < 0.05$; 1.76, [1.12, 2.77], $p < 0.05$) and weekdays (1.82, [1.18, 2.82], $p < 0.01$; 1.90, [1.21, 2.98], $p < 0.01$). After controlling for socio-demographic covariates, regarding the screen exposure standard of 60 min/d was exceeded, children whose primary caregiver was non-mother showed a tendency to be more liable to excessively use electronic screens on weekends than those being cared for by mothers (1.41, [1.07, 1.86], $p < 0.01$; 2.32, [1.25, 4.32], $p < 0.01$). Overall, compared with mentally healthy caregivers, depressed caregivers were more prone to overexposure children to screens, especially when the average daily exposure time exceeded 120 min (1.77, [1.21, 2.59], $p < 0.01$; 1.83, [1.25, 2.68], $p < 0.01$; 1.46, [1.06, 2.01], $p < 0.05$). As for the scores of disciplining practices, there was a negative correlation with excessive exposure. In this study, regardless of whether 60 min or 120 min was used as the over-exposure index, the lower the score of disciplinary practices, the more prevalent the excessive exposure to electronic screens among these children.

Discussion

In this study, we found that parental migration experiences exerted distinct impacts on children's excessive screen exposure in the context of China's mass migration. Our findings manifested that parental migration experience, type of caregiver, depression status and disciplinary practices of the caregiver were significantly related to children's excessive screen exposure. Compared to the other groups of children, PLBC was more likely to be exposed to screens for learning activities. Children cared for by depressed caregivers had been excessively exposed to electronic screens for more than 120 min/day in the past week. Likewise, children cared for by non-maternal caregivers significantly overused electronic screens on weekends. In the measurement of disciplinary practices, the higher the score of discipline practices, the less time children spent on screen use.

First, research showed that LBC's parents had lower education attainment but better household incomes, compared to PLBC and NLBC. This was due to the fact that the proportion of LBC with one or both parents employed was the highest. This was inconsistent with the literature [30, 52]. In terms of primary caregivers, the proportion of LBC whose primary caregivers were grandmothers was significantly higher than that of PLBC and NLBC. As parents migrated from rural to urban areas in pursuit of improved job prospects, they were often compelled to entrust their children to the care of grandparents [53]. It is noteworthy that nearly a quarter of NLBC are not primarily cared for by the mother, even if the parents have never left their hometown. Hence, the phenomenon of grandparents helping their children to raise their grandchildren is very common in China.

Second, regardless of using 60 min/day or 120 min/day as the standard for excessive screen exposure, the three groups of children all had statistically significant differences in average daily screen use time over the past week. In comparison, PLBC was more prone to overexposure to screen than both LBC and NLBC. After adjusting for socio-demographic variables, these results remained significant. Numerous studies in China have shown that migrant families had adverse effects on children's healthy development [39, 54, 55]. To our surprise, it was PLBC, rather than LBC, that lagged behind in multiple aspects. Previous studies reported that PLBC had poorer parent–child communication and more time spent online, leading to an increased incidence of cyberbullying [56]. In the measurement of mental health, PLBC significantly scored higher for total difficulties along with emotional symptoms and conduct problems [30]. PLBC appeared to be at a greater disadvantage regarding peer relationships [52]. It is difficult for migrant parents to reverse the complex consequences of their long-term absence in their children's lives by returning home. Even changes in primary caregiver and family structure resulting from their return might bring new challenges to the children's lives [57]. This may be used to explain why PLBC continue to use screens excessively and engage in recreational activities possibly despite parental care.

Table 4 Regression analysis for screen exposure by different types of children, OR (95%CI), $n = 1290$

Set 60 min/d as the excessive screen exposure standard	Screen exposure (average day of the week)[i]		Screen exposure (average day on weekdays)[j]		Screen exposure (average day on weekends)[k]	
	model1	model2	model1	model2	model1	model2
Parental migration status (ref: NLBC)						
LBC	0.99 (0.77, 1.25)	0.93 (0.72, 1.19)	1.04 (0.82, 1.33)	1.01 (0.78, 1.29)	1.01 (0.79, 1.29)	0.95 (0.73, 1.23)
PLBC	1.47 (1.05, 2.02)*	1.40 (1.00, 1.96)*	1.33 (0.96, 1.84)	1.29 (0.93, 1.81)	1.08 (0.77, 1.51)	0.99 (0.70, 1.40)
Primary caregiver (ref: Mother)						
Grandmother		1.32 (1.01, 1.72)*		1.23 (0.94, 1.60)		1.41 (1.07, 1.86)*
Other		1.45 (0.85, 2.46)		1.13 (0.66, 1.91)		2.32 (1.25, 4.32)**
Depression in caregiver (ref: No)						
Yes		1.31 (0.97, 1.76)		1.14 (0.85.1.53)		1.15 (0.84, 1.57)
Score of disciplinary practices		0.87 (0.78, 0.98)*		0.87 (0.77, 0.98)*		0.90 (0.80, 1.02)
Set 120 min/d as the excessive screen exposure standard	Screen exposure (average day of the week)[#]		Screen exposure (average day on weekdays)[%]		Screen exposure (average day on weekends)[*]	
	model1	model2	model1	model2	model1	model2
Parental migration status (ref: NLBC)						
LBC	1.23 (0.87, 1.76)	1.23 (0.85, 1.78)	1.17 (0.82, 1.68)	1.19 (0.82, 1.73)	1.08 (0.83, 1.42)	1.00 (0.75, 1.33)
PLBC	1.74 (1.12, 2.69)*	1.76 (1.12, 2.77)*	1.82 (1.18, 2.82)**	1.90 (1.21, 2.98)**	1.39 (0.97, 1.97)	1.28 (0.89, 1.84)
Primary caregiver (ref: Mother)						
Grandmother		1.10 (0.75, 1.60)		1.03 (0.70, 1.52)		1.22 (0.91, 1.63)
Other		1.44 (0.73, 2.86)		1.53 (0.77, 3.04)		1.66 (0.95, 2.89)
Depression in caregiver (ref: No)						
Yes		1.77 (1.21, 2.59)**		1.83 (1.25, 2.68)**		1.46 (1.06, 2.01)*
Score of disciplinary practices		0.91 (0.77, 1.08)		0.93 (0.79, 1.10)		0.86 (0.76, 0.99)*

Note: (Table 3 ***and*** Table 4***)***

Model 1: No adjustment for covariates was made. Model 2: Adjusted by age, gender, only child, maternal age at childbirth, monthly household income, parental highest education level, parental marital status, parental current work status

*: $p < 0.05$

**: $p < 0.01$

***: $p < 0.001$

[a]: Model 1: $n = 1290$, Nagelkerke $R^2 = 0.007$, $p = 0.177$; Model 2: $n = 1290$, Nagelkerke $R^2 = 0.101$, $p < 0.001$

[b]: Model 1: $n = 1204$, adjusted $R^2 = 0.000$, $F = 0.912$, $p = 0.402$; Model 2: $n = 1204$, adjusted $R^2 = 0.010$, $F = 1.888$, $p = 0.024$

[c]: Model 1: $n = 1204$, adjusted $R^2 = -0.001$, $F = 0.422$, $p = 0.656$; Model 2: $n = 1204$, adjusted $R^2 = 0.010$, $F = 1.854$, $p = 0.027$

[d]: Model 1: $n = 1204$, adjusted $R^2 = 0.002$, $F = 2.109$, $p = 0.122$; Model 2: $n = 1204$, adjusted $R^2 = 0.019$, $F = 2.639$, $p = 0.001$

[e]: Model 1: $n = 1290$, Nagelkerke $R^2 = 0.003$, $p = 0.262$; Model 2: $n = 1290$, Nagelkerke $R^2 = 0.075$, $p < 0.001$

[f]: Model 1: $n = 743$, adjusted $R^2 = 0.010$, $F = 4.681$, $p = 0.010$; Model 2: $n = 743$, adjusted $R^2 = 0.047$, $F = 3.590$, $p < 0.001$

[g]: Model 1: $n = 743$, adjusted $R^2 = 0.006$, $F = 3.358$, $p = 0.035$; Model 2: $n = 743$, adjusted $R^2 = 0.038$, $F = 3.105$, $p < 0.001$

[h]: Model 1: $n = 743$, adjusted $R^2 = 0.012$, $F = 5.373$, $p = 0.005$; Model 2: $n = 743$, adjusted $R^2 = 0.044$, $F = 3.443$, $p < 0.001$

[i]: Model 1: $n = 1290$, Nagelkerke $R^2 = 0.006$, $p = 0.052$; Model 2: $n = 1290$, Nagelkerke $R^2 = 0.043$, $p = 0.001$

[j]: Model 1: $n = 1290$, Nagelkerke $R^2 = 0.003$, $p = 0.222$; Model 2: $n = 1290$, Nagelkerke $R^2 = 0.029$, $p = 0.047$

[k]: Model 1: $n = 1290$, Nagelkerke $R^2 = 0.000$, $p = 0.910$; Model 2: $n = 1290$, Nagelkerke $R^2 = 0.068$, $p < 0.001$

[#]: Model 1: $n = 1290$, Nagelkerke $R^2 = 0.008$, $p = 0.052$; Model 2: $n = 1290$, Nagelkerke $R^2 = 0.048$, $p = 0.008$

[%]: Model 1: $n = 1290$, Nagelkerke $R^2 = 0.010$, $p = 0.031$; Model 2: $n = 1290$, Nagelkerke $R^2 = 0.052$, $p = 0.004$

[*]: Model 1: $n = 1290$, Nagelkerke $R^2 = 0.004$, $p = 0.199$; Model 2: n = 1290, Nagelkerke $R^2 = 0.047$, $p = 0.001$

At the same time, in the adjusted model, we also found that parents' migration back home significantly affected children's use of screen time for learning activities. From this we can infer a reliable reason why PLBC's parents choose to migrate back to care for them precisely because their children exhibits excessive screen exposure or other health-damaging behaviors.

In addition, in Chinese culture, raising children is still primarily the responsibility of the mother [58]. When the primary caregiver was non-mother, children were more likely to spend more than 60 min/day on screens, indicating excessive exposure to electronic screens, particularly on weekends. The most important reasons to explain this phenomenon are that the elderly have lower educational

levels, outdated ideas and limited upbringing energy [59]. Therefore, grandparents give their grandchildren more love by only maintaining a relationship of companionship, rather than discipline their screen exposure behavior [60]. Consistent with the viewpoint of existing research [61], when caregivers exhibited depressive symptoms, their children tended to spend an extended amount of time using screens and were more likely to experience daily screen exposure exceeding two hours. Depressive symptoms can lead to changes in parenting behavior, often manifested as less time, effort, and emotional investment in children and negative parent–child interactions [47]. Yet, we were surprised to find that children cared for by depressed caregivers were more likely to exposure electronic screen for learning activities. This phenomenon deserved significant attention in future research.

Finally, after controlling for other factors, the important finding of this study was that the more positive the disciplinary practices of the caregiver, the less time children spent on entertainment through electronic screens. Based on these evidences, we can infer that positive disciplinary practices can strengthen parent–child relationships and increase parent–child dependence, thereby effectively restricting children's screen time.

Several limitations in this study need to be noticed. First, the cross-sectional design could not be used to interpret cause-effect relationship. Further research should be conducted using a longitudinal approach. Second, we used a screen use variable reported by caregivers, which inevitably lead to a degree of random measurement error due to recall bias, which may underestimate or overestimate true exposure. Third, using different investigation modes to conduct children aged 1–36 months and 37–66 months may influence the results. Finally, we only took samples from one county in Anhui Province, even though the samples involved were almost spread across the entire county. Therefore, these results may not be applicable to children and parents in other regions of China. Future research should include more samples of children and parents. In subsequent studies, we would gradually expand our research nationwide, and by then, research in this field could be more fruitful.

Conclusions

Despite the above limitations, our study provides preliminary evidence for the correlation between different types of parental migration in rural China and children's excessive screen use. Additionally, it delves into the influence of caregiver type, caregiver depression, and disciplinary practices on children's screen use. In this study, excessive screen exposure among the three groups of children tended to occur more frequently during the weekends. Furthermore, when the caregiver was non-mother or when the caregiver was experiencing depression, it also led to the children's excessive use of electronic screens. Given that the number of left-behind children would not decrease significantly in a short time, we should call on parents to increase their attention and supervision of LBC and PLBC. In addition, establishing a family media use plan (limiting screen time and content) is necessary and increasing parental intervention may be a promising approach to reduce total screen time and cultivate good screen use habits in children aged 1–66 months. Our research findings positively influence policies and initiatives aimed at fostering healthy screen habits among children left behind in rural areas. In the future, the scale of research needs to be expanded to further study the influencing factors and intervention measures related to children's screen time, with a view to providing suggestions for relevant policies and guidelines for children's screen time.

Abbreviations

LBC	Left-behind children
PLBC	Previously left-behind children
NLBC	Never left-behind children
BDI-II	Beck Depression Inventory-II

Supplementary Information

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Supplementary Material 1.

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Authors' contributions

FW was involved in the conceptualization and providing the resources. The investigation was conducted by YXZ, YTC, YW, GLZ and FW. YXZ, YTC, YW completed the data curation and YXZ performed the formal analysis. YXZ and YTC wrote the original draft and contributed as co-first authors. XHW, FW and TS supervised the project and reviewed and edited this manuscript. All authors have read and approved the final manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

Each caregiver in the survey signed an informed consent form. The study was conducted in accordance with the Declaration of Helsinki and has been

approved by the Ethics Committee of Hangzhou Normal University (Number: 2023–1047).

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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References

1. Sweetser P, Johnson D, Ozdowska A, Wyeth P. Active versus passive screen time for young children. Australas J Early Childhood. 2012;37:94–8.
2. Tang L, Hruska V, Ma DWL, Haines J, Study GFH. Parenting under pressure: stress is associated with mothers' and fathers' media parenting practices in Canada. J Child Media. 2021;15:233–48.
3. Thomas G, Bennie JA, De Cocker K, Castro O, Biddle SJH. A descriptive epidemiology of screen-based devices by children and adolescents: a scoping review of 130 surveillance studies since 2000. Child Indic Res. 2020;13:935–50.
4. Gao R, Xu H, Luo H, Zhang J, Li T, Kuang H, et al. Correlation analysis of electronic screen use and myopia among primary and secondary school students in six provinces and cities of China. Chin J Sch Health. 2024;45:882.
5. Hale L, Guan S. Screen time and sleep among school-aged children and adolescents: a systematic literature review. Sleep Med Rev. 2015;21:50–8.
6. Twenge JM, Spitzberg BH, Campbell WK. Less in-person social interaction with peers among US adolescents in the 21st century and links to loneliness. J Soc Pers Relat. 2019;36:1892–913.
7. Adhikari B. Use of screen media and mental health: effects on adolescents and pre-adolescents. J Nepal Med Assoc. 2021;59:962–4.
8. Jake-Schoffman DE, Turner-McGrievy G, Walsemann KM. Wired: Parent–child relationship quality and recreational media use in a diverse sample of US children and adolescents. J Child Media. 2017;11:347–57.
9. Erat Nergiz M, Çaylan N, Yalçin SS, Oflu A, Tezol Ö, Foto Özdemir D, et al. Excessive screen time is associated with maternal rejection behaviours in pre-school children. J Paediatr Child Health. 2020;56:1077–82.
10. Dennison BA, Erb TA, Jenkins PL. Television viewing and television in bedroom associated with overweight risk among low-income preschool children. Pediatrics. 2002;109:1028–35.
11. Zimmerman FJ, Christakis DA. Children's television viewing and cognitive outcomes: a longitudinal analysis of national data. Arch Pediatr Adolesc Med. 2005;159:619–25.
12. Rocha HAL, Correia LL, Leite ÁJM, Machado MMT, Lindsay AC, Rocha SGMO, et al. Screen time and early childhood development in Ceará, Brazil: a population-based study. BMC Public Health. 2021;21:1–8.
13. Xie G, Deng Q, Cao J, Chang Q. Digital screen time and its effect on preschoolers' behavior in China: results from a cross-sectional study. Ital J Pediatr. 2020;46:1–7.
14. World Health Organization. To grow up healthy, children need to sit less and play more: New WHO guidelines on physical activity, sedentary behaviour and sleep for children under 5 years of age. 2019. https://www.who.int/news-room/detail/24-04-2019-to-grow-up-healthy-children-need-to-sit-less-and-play-more . Accessed 13 May 2024 .
15. American Academy of Pediatrics. Beyond screen time: help your kids build healthy media use habits. 2022. https://www.healthychildren.org/English/family-life/Media/Pages/healthy-digital-media-use-habits-for-babies-toddlers-preschoolers.aspx. Accessed 18 May 2024 .
16. Reid Chassiakos Y (Linda), Radesky J, Christakis D, Moreno MA, Cross C, Council on Communications and Media, et al. Children and adolescents and digital media. Pediatrics. 2016;138:e20162593.
17. Council on Communications and Media, Strasburger VC, Hogan MJ, Mulligan DA, Ameenuddin N, Christakis DA, et al. Children, adolescents, and the media. Pediatrics. 2013;132:958–61.
18. Council on Communications and Media. Hill D, Ameenuddin N, Reid Chassiakos Y (Linda), Cross C, Hutchinson J, et al. Media and young minds. Pediatrics. 2016;138:e20162591.
19. Houghton S, Hunter SC, Rosenberg M, Wood L, Zadow C, Martin K, et al. Virtually impossible: limiting Australian children and adolescents daily screen based media use. BMC Public Health. 2015;15:1–11.
20. Hamer M, Stamatakis E, Mishra G. Psychological distress, television viewing, and physical activity in children aged 4 to 12 years. Pediatrics. 2009;123:1263–8.
21. Yalçin SS, Tezol Ö, Çaylan N, Erat Nergiz M, Yildiz D, Çiçek Ş, et al. Evaluation of problematic screen exposure in pre-schoolers using a unique tool called "seven-in-seven screen exposure questionnaire": cross-sectional study. BMC Pediatr. 2021;21:472.
22. Çaylan N. Associations between parenting styles and excessive screen usage in preschool children. Turk Pediatri Ars. 2020. https://doi.org/10.14744/TurkPediatriArs.2020.43765. Accessed 17 Jun 2024.
23. Paulus FW, Joas J, Friedmann A, Fuschlberger T, Möhler E, Mall V. Familial context influences media usage in 0 to 4 year old children. Front Public Health. 2024;11:1256287.
24. Schwarzer C, Grafe N, Hiemisch A, Kiess W, Poulain T. Associations of media use and early childhood development: cross-sectional findings from the LIFE Child study. Pediatr Res. 2022;91:247–53.
25. Tandon PS, Zhou C, Lozano P, Christakis DA. Preschoolers' total daily screen time at home and by type of child care. J Pediatr. 2011;158:297–300.
26. Bjelland M, Soenens B, Bere E, Kovács É, Lien N, Maes L, et al. Associations between parental rules, style of communication and children's screen time. BMC Public Health. 2015;15:1–13.
27. Maitland C, Stratton G, Foster S, Braham R, Rosenberg M. A place for play? The influence of the home physical environment on children's physical activity and sedentary behaviour. Int J Behav Nutr Phys Act. 2013;10:1–21.
28. Miguel-Berges ML, Santaliestra-Pasias AM, Mouratidou T, Flores-Barrantes P, Androutsos O, De Craemer M, et al. Parental perceptions, attitudes and knowledge on European preschool children's total screen time: the ToyBox-study. Eur J Public Health. 2020;30:105–11.
29. Goh S, Teh L, Tay W, Anantharaman S, van Dam R, Tan C, et al. Sociodemographic, home environment and parental influences on total and device-specific screen viewing in children aged 2 years and below: an observational study. BMJ Open. 2016;6:e009113.
30. Akezhuoli H, Lu JJ, Zhao GL, Xu JY, Wang MM, Wang F, et al. Mother's and father's migrating in China: differing relations to mental health and risk behaviors among left-behind children. Front Public Health. 2022;10:894741.
31. Tian X, Ding C, Shen C, Wang H. Does parental migration have negative impact on the growth of left-behind children?—new evidence from longitudinal data in rural China. Int J Environ Res Public Health. 2017;14:1308.
32. Wen M, Lin D. Child development in rural China: children left behind by their migrant parents and children of nonmigrant families. Child Dev. 2012;83:120–36.
33. Fatima H, Zhao S, Yue A, Li S, Shi Y. Parental discipline and early childhood development in rural China. Sustainability. 2022;14:1–12.
34. Lansford JE, Wager LB, Bates JE, Dodge KA, Pettit GS. Parental reasoning, denying privileges, yelling, and spanking: ethnic differences and associations with child externalizing behavior. Parenting. 2012;12:42–56.
35. Sege RD, Siegel BS, Flaherty EG, Gavril AR, Idzerda SM, Laskey A "Toni," et al. Effective discipline to raise healthy children. Pediatrics. 2018;142(6):e20183112.
36. Brophy S, Todd C, Rahman MA, Kennedy N, Rice F. Timing of parental depression on risk of child depression and poor educational outcomes: a population based routine data cohort study from Born in Wales. UK PLoS One. 2021;16:e0258966.
37. Chad-Friedman S, Zhang I, Donohue K, Chad-Friedman E, Rich BA. Reciprocal associations between parental depression and child cognition: pathways to children's internalizing and externalizing symptoms. Dev Psychopathol. 2023:1–11.
38. Zhou C, Sylvia S, Zhang L, Luo R, Yi H, Liu C, et al. China's left-behind children: impact of parental migration on health, nutrition, and educational outcomes. Health Aff. 2015;34:1964–71.
39. Ban L, Guo S, Scherpbier R, Wang X, Zhou H, Tata L. Child feeding and stunting prevalence in left-behind children: a descriptive analysis of

data from a central and western Chinese population. Int J Public Health. 2017;62:143–51.
40. National Bureau of Statistics of China, UNICEF China, UNFPA China. What the 2020 census can tell us about children in China: facts and figures. 2023. https://www.unicef.cn/en/reports/population-status-children-china-2020-cens . Accessed 13 May 2024 .
41. Zheng W, He F. Sample size estimate for cross-sectional study. China Prevent Med J. 2020;32:647–8.
42. National Bureau of Statistics. Final statistical monitoring report of "China Children's Development Outline (2011–2020)." 2021. https://www.stats.gov.cn/xxgk/sjfb/zxfb2020/202112/t20211221_1825527.html. Accessed 26 Jun 2024.
43. Liang X, Lin Y, Van IJzendoorn MH, Wang Z. Grandmothers are part of the parenting network, too! A longitudinal study on coparenting, maternal sensitivity, child attachment and behavior problems in a Chinese sample. New Dir Child Adolesc Dev. 2021;2021:95–116.
44. Beck AT, Steer RA, Ball R, Ranieri WF. Comparison of beck depression inventories-IA and-II in psychiatric outpatients. J Pers Assess. 1996;67:588–97.
45. Regalado M, Sareen H, Inkelas M, Wissow LS, Halfon N. Parents' discipline of young children: results from the national survey of early childhood health. Pediatrics. 2004;113(Suppl 5):1952–8.
46. Wissow LS. Ethnicity, Income, and parenting contexts of physical punishment in a national sample of families with young children. Child Maltreat. 2001;6:118–29.
47. Yang J, Jiang Q, Yue A, Tang L, Nie J. Effects of caregiver depression on parenting behaviors in poor rural China. J East China Norm Univ (Educational Sciences). 2019;37:97.
48. Zhang Q. The effects of screen exposure and parental media intervention on media addiction in preschool children. Stud Early Childhood Educ. 2023;11:42–54.
49. Wang H, Zhao J, Yu Z, Pan H, Wu S, Zhu Q, et al. Types of on-screen content and mental health in kindergarten children. JAMA Pediatr. 2024;178:125–32.
50. Zimmerman FJ, Christakis DA, Meltzoff AN. Television and DVD/video viewing in children younger than 2 years. Arch Pediatr Adolesc Med. 2007;161:473–9.
51. Chen B, Bernard J, Padmapriya N, Ning Y, Cai S, Lança C, et al. Associations between early-life screen viewing and 24 hour movement behaviours: findings from a longitudinal birth cohort study. Lancet Child Adolesc Health. 2020;4:201–9.
52. Zhao C, Wang F, Li L, Zhou X, Hesketh T. Long-term impacts of parental migration on Chinese children's psychosocial well-being: mitigating and exacerbating factors. Soc Psychiatry Psychiatr Epidemiol. 2017;52:669–77.
53. Zhao D, Zhou Z, Shen C, Ibrahim S, Zhao Y, Cao D, et al. Gender differences in depressive symptoms of rural Chinese grandparents caring for grandchildren. BMC Public Health. 2021;21:1838.
54. Gao Y, Li L, Kim J, Congdon N, Lau J, Griffiths S. The impact of parental migration on health status and health behaviours among left behind adolescent school children in China. BMC Public Health. 2010;10:1–10.
55. Zhang N, Bécares L, Chandola T. Does the timing of parental migration matter for child growth? A life course study on left-behind children in rural China. BMC Public Health. 2015;15:1–12.
56. Wang M, Lou J, Xie X, Zhao G, Zhu H. Parental migration and cyberbullying victimization among Chinese left-behind children: understanding the association and mediating factors. Front Public Health. 2024;12:1194940.
57. Lu Y, Zhang R, Du H. Family structure, family instability, and child psychological well-being in the context of migration: evidence from sequence analysis in China. Child Dev. 2021;92:e416–38.
58. Gao Y, Li L, Chan E, Lau J, Griffiths S. Parental migration, self-efficacy and cigarette smoking among rural adolescents in south China. PLoS ONE. 2013;8:e57569.
59. Liu C, Zhang Z, Liao J, Liang Y, Ge J. A study on the types of Inter-Generational Education for rural left-behind children—taking a town in Ya'an City, Sichuan Province as an example. Adv Educ. 2024;14:809–16.
60. Breheny M, Stephens C, Spilsbury L. Involvement without interference: how grandparents negotiate intergenerational expectations in relationships with grandchildren. J Fam Stud. 2013;19:174–84.
61. Hoyos Cillero I, Jago R. Systematic review of correlates of screen-viewing among young children. Prev Med (Baltim). 2010;51:3–10.

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