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Digital media use in early childhood - contextual factors, developmental outcomes and pathways

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Digital media use in early childhood - contextual factors, developmental outcomes and pathways

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Editorial: Digital media use in early childhood—contextual factors, developmental outcomes, and pathways

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early childhood, screen time (ST), technoference, parenting (MeSH), digital media, infants

Editorial on the Research Topic
Digital media use in early childhood—contextual factors, developmental outcomes and pathways

Introduction

The digitalization of our world and the associated changes in daily life are influencing how infants and toddlers grow up. Digital media, the internet, and screens of various sizes have become an integral part of most families' lives, often with multiple devices per household. Especially the rapidly emerging portable devices, such as smartphones, tablets, or laptops, provide unrestricted access to screen media anywhere and anytime. It is therefore hardly surprising that the daily use of digital screen devices has not only increased in the general population in the last decade, but also in very young children (1). For instance, screen time in American families has risen in infants (0–2 years) from 1.32 h per day in 1997 to 3.05 h per day in 2014, which included an average of 2.62 h of television viewing and 0.37 h on mobile devices. According to the most recent Common Sense Census, children under the age of 2 spend approximately 1 h per day on a screen (2). Surveys on parental use of screen technologies for their children show that care-takers often use screen media to distract their children from emotional or physical discomfort—to calm them down, to stop tantrums, to enable feeding, or to put them to sleep (3). Other reasons for media use are: keeping children occupied when parents are doing housework, trying to work, are out at an event, or simply if they need a break (4).

Early childhood is a sensitive developmental period during which close, responsive relationships and rich multisensory experiences are essential for healthy cognitive, socio-emotional, language and motor development. Three particularly salient risks have emerged in this context: (a) the direct use of screen media by young children and (b) technoference—the disruption of parent-child interactions due to parental media use, and (c) the lower use of embodied motor activities. The developmental implications of these patterns remain insufficiently understood and warrant further investigation.

There has been concern that direct screen media exposure may harm children's development, especially if screen use starts very early in life and takes up as lot of time in the child's life. The first 3 years of a child's life are a period of rapid brain development, including cognitive, language, social, and motor processes (5). Within 36 months, the child turns from a completely dependent newborn to a remarkably complex individual who shares thoughts, feelings, and intentions with others, expresses him- or herself by using words, and understands social signals and norms. The World Health Organization (WHO), and many other organizations invested in early childhood health and development discourage screen media use for children younger than 18 or 24 months, respectively, and recommend limiting sedentary screen media exposure for children between 2 and 5 years to 1 h per day restricted to high-quality screen content (6, 7). However, recent cohort studies indicate that many families do not follow these guidelines (8). In the study of Putnick et al. (9) about 17% of the assessed infants started using screen media during the first year of life with approximately 1 h per day, increasing to 2–3 h per day at the age of 2–3 years. The increased use of digital media in early childhood is associated with a displacement of time spent in physically active or social play, which is essential for sensorimotor, cognitive, and socio-emotional development (10, 11). Motor activities in infancy and early childhood contribute not only to gross and fine motor skills but also to the development of executive functions, self-regulation, and spatial cognition (12). Sedentary screen use may thus reduce opportunities for children to explore their environment, engage in goal-directed movement, and interact with caregivers or peers through physically co-regulated play. These limitations can, in turn, have downstream effects on developmental cascades, particularly in vulnerable populations. The indirect effects of screen exposure include also parental technoference, which describes parental use of technology during a social interaction with their child. Parents act as role models for mobile screen media use and show reduced responsivity and availability for their children when using a smartphone, with potential negative consequences for child mental wellbeing (13).

With this Research Topic, we aimed to deepen the scientific discourse on how digital media use may affect early development, while considering the complex and dynamic systems within which children grow. The contributions span a variety of methodologies—including longitudinal designs, process evaluations, parental surveys, behavioral observations, and population-based cohort studies—and offer a multifaceted view of the topic.

Looking at potential mechanisms and contextual factors in the association between screen use and child development, Konok et al. , investigated how parental use of digital media for emotional regulation is associated with the development of self-regulatory skills in children. Their study highlights a potentially important intergenerational pathway by which media use patterns are transmitted and internalized.

Other contextual factors that were featured prominently were family routines and parental strategies. Drawing on data from a large Canadian cohort, the study by Lien et al. explored the role of limit-setting and routines in shaping children's screen use during the pandemic. Meanwhile, Fitzpatrick et al. demonstrated how parents' own media habits may influence children's global developmental outcomes. Finally, the research group of Paulus et al. provided further evidence for the role of the familial context in shaping digital media use among children aged 0–4 years. Findings of this paper underscore that media habits do not arise in a vacuum but are embedded in a broader socio-emotional and relational framework that includes parental stress, parenting styles, and environmental factors.

Turning to the microsystem of parent-child interaction, Liszkai-Peres et al. and Chamam et al. examined the effects of mobile touchscreen device use on dyadic communication. While Liszkai-Peres et al. focused on how device use during interactions may degrade interaction quality, the comparative study on digital vs. non-digital distraction published by Chamam et al. provided nuanced insights into the varying impact of different types of parental inattention.

Finally, some studies also examined potential intervention approaches. In a process evaluation of a large-scale intervention, Schemmer et al. applied the RE-AIM framework, a widely used tool to evaluate the impact and sustainability of health interventions in real-world settings. RE-AIM stands for: Reach, Effectiveness, Adoption, Implementation, and Maintenance (14). Schemmer et al. assessed the implementation and effectiveness of a Germany-wide program aimed at preventing dysregulated screen time use in children under 3. This work emphasizes the importance of structural prevention efforts and implementation science in shaping healthy digital habits from the start. Complementing this, Fitzpatrick et al. identified effective parenting strategies for meeting screen time recommendations.

Taken together, the articles in this Research Topic illustrate that the developmental effects of digital media in early childhood strongly depend on context of screen use. They highlight the need for integrative research approaches that consider parental characteristics, interaction quality, family systems, and longitudinal trajectories. Figure 1 illustrates the multifactorial influences of early screen use on infant development, focusing on three core developmental domains: cognitive & language development, motor development, and socio-emotional development. It provides a conceptual overview of how various contextual, individual, and environmental factors interact with digital media use in early childhood. The illustration is based on the assumption that developmental effects of screen use depend not only on how much but also on how, what, and with whom media is consumed—emphasizing the need for age-appropriate, co-regulated, and developmentally sensitive media use.

Far from demonizing digital media, these contributions call for a more differentiated understanding of its place in modern childhood—and of the protective and risk factors that modulate its effects.

We are grateful to the authors and reviewers who contributed their expertise to this Research Topic. We hope this issue stimulates

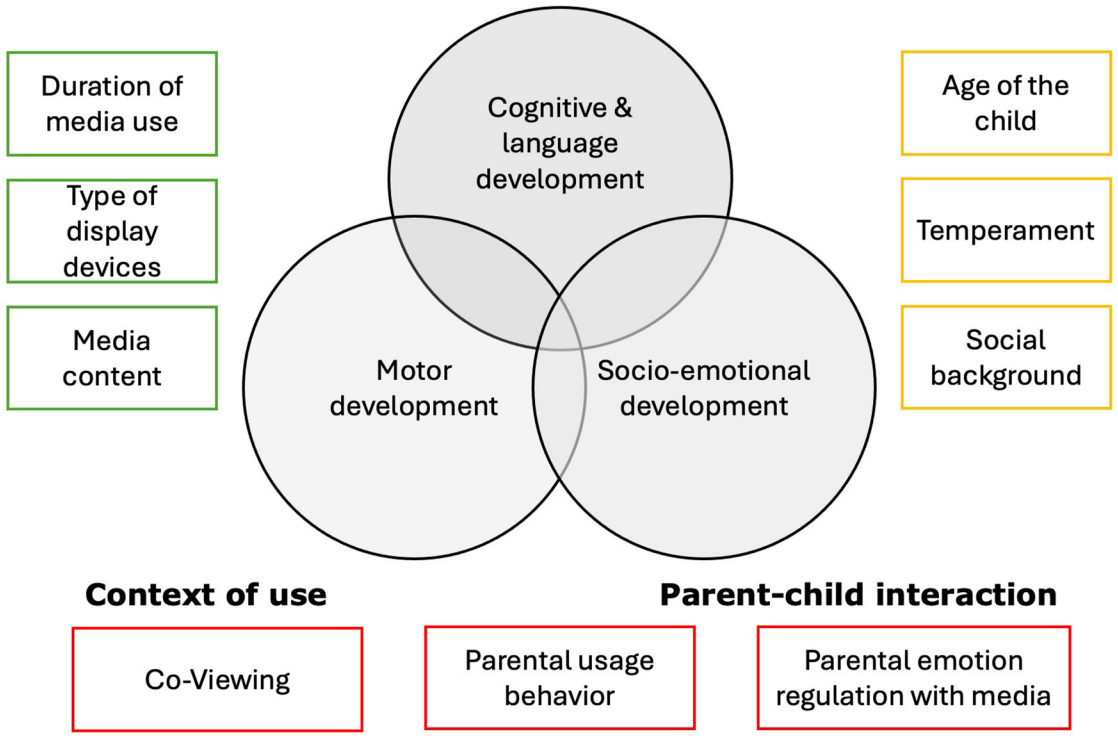

FIGURE 1
Overview of research findings on early childhood screen use: developmental outcomes and contextual factors.

ongoing dialogue, policy reflection, and research innovation aimed at promoting healthy development in a digital world.

Author contributions

MB: Writing – original draft, Writing – review & editing. EU: Writing – original draft, Writing – review & editing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Meeting preschool screen time recommendations: which parental strategies matter?

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Background: High levels of screen use by preschoolers may contribute to adverse health and developmental outcomes. Little is known about which parental strategies may be protective against intensive screen use by children. Our aim is to estimate whether parent strategies for mediating child screen time including restrictive and instructive mediation and social coviewing, predict preschooler adherence to the screen time recommendation of ≤1 h/day during the COVID-19 pandemic. We also examine if parent restrictive mediation interacts with child temperament characteristics.

Methods: Our sample is composed of 315 Canadian parents of preschoolers surveyed during the COVID-19 pandemic. Parents provided measures of child adherence to screen time guidelines at ages 3.5 (baseline) and 4.5 years. Parents also reported how often they used restrictive and instructional mediation, and social coviewing to manage their child's screen use. Control variables include child sex and temperament (effortful control, negative affectivity, extraversion), educational attainment, and parenting stress at age 3.5.

Results: A logistic regression revealed that parental restrictiveness was associated with a 4 time increase in the odds of adherence to screen time guidelines, OR = 4.07 (95% CI [1.70–13.03]). Parental social coviewing decreased the chances of adherence by 80% (OR = 0.20, 95% CI [0.09–0.48]). Furthermore, children not meeting recommendation at 3.5 were 98% less likely to respect the recommendation 1 year later (OR = 0.02, 95% CI [0.01–0.07]). Results were adjusted for child sex, temperament, baseline screen time, and parent education and stress The interaction between the restriction mediation and child temperament on later screen time was not significant.

Conclusion: Our results indicate that some parental strategies may be more effective than others for managing preschooler screen time. Parent use of restrictive mediation was most likely to forecast child adherence to later screen time recommendations. The present results may contribute to the development of targeted family-based interventions designed to promote healthy development from a young age.

KEYWORDS

screen time, screen use, guidelines, parent mediation, parental monitoring, preschooler, early childhood

Introduction

The amount of time preschoolers accumulate in front of screens can undermine later fitness, sleep quality, and school readiness (Jones et al., 2013; Madigan et al., 2019; Lan et al., 2020). Since habits and behaviors developed in early childhood are likely to be carried forward in later life stages, helping children develop healthy screen time habits during the preschool years may promote lifelong health and decreased morbidity (Jones et al., 2013). The World Health Organization currently recommends that children between the ages of 2 and 5 be exposed to a maximum of 1 h of daily screen time (World Health Organization, 2019). Research conducted prior to COVID-19 pandemic has found that half or less of Canadian children respect these guidelines (Carson et al., 2013; Tamana et al., 2019). The increased sedentariness of young children is of particular concern given that the cardiorespiratory health of children between the ages of 6 and 17 has been declining over the last decades (Leone et al., 2023). Furthermore, there has been a dramatic raise in children that are overweight or obese internationally (Ng et al., 2014).

Child screen use occurs within their larger family ecology (Barr, 2019). As such, parental strategies represent promising intervention targets for helping children develop healthy screen use habits. Based on previous research, parents use three strategies to manage child screen use (Valkenburg et al., 1999). A first strategy is the use of *restrictive mediation* which includes parents setting limits on child screen time and establishing rules surrounding what contents children may view. A second strategy, *instructive mediation* refers to parents discussing the content of media with children in an attempt to help foster learning. Finally, *social coviewing* involves parent viewing media with children for enjoyment purposes rather than educational ones (Valkenburg et al., 1999; Livingstone and Helsper, 2008).

Few studies have prospectively examined how parent strategies for managing child screen time contribute to later adherence to screen time recommendations and existing studies have provided mixed results. One study with school-aged children and adolescents has found that parent use of restrictive strategies can help reduce child screen time and prevent excessive internet use (Fu et al., 2020). In contrast, another study has found that restrictive practices may lead adolescents to engage in more screen use (Hefner et al., 2019). According to one qualitative study on 5–6 years-olds, rule setting appears to be a promising approach for managing screen time (Jago et al., 2016). Furthermore, cross-sectional data support a negative association between parental restrictive mediation and preschooler screen time (Fitzpatrick et al., 2022a). Currently, it also unclear if parenting contributes to child media habits, or if parenting strategies are shaped by children's screen use habits and preferences. That is, parents who perceive their child's screen use as more problematic may be more likely to adopt restrictive mediation. For this reason, prospective studies that control for baseline child screen time are helpful for shedding light on the direction of these associations.

Active forms of mediation like instruction and social coviewing have been shown to help protect 8–14 years-old children from problematic internet and phone use (Hefner et al., 2019). Furthermore, active mediation by parents has been linked to lower odds of excessive internet use cross-sectionally in adolescents (Kalmus et al., 2015). Finally, according to a meta-analysis, both restrictive mediation and coviewing may reduce child screen time, whereas parental instruction was associated with reduced child aggression and substance use in older children and adolescents (Collier et al., 2016). Research on the benefits of restriction, instruction, and social coviewing on younger children remains sparse.

In addition to child age, individual differences in child self-control may also moderate associations between restrictive practices and child screen time habits. For instance, Lee (2013), found that adolescents with lower levels of self-control may benefit more from restrictive mediation than those with higher levels of self-control. These associations remain unexamined with younger preschool-aged children. In early childhood, the ability to exercise self-control over emotions, behavior, and attention are strongly influenced by children's temperamental characteristics which include dimensions of effortful control (ex., reflecting attentional focusing and inhibitory control), negative affectivity (ex., frequency of expression of anger and frustration), and extraversion (ex., tendency to act impulsivity) (Putnam and Rothbart, 2006). For this reason, the extent to which restrictive mediation, which involves the implementation of rules and restrictions, may interact with child temperament to influence child screen use habits.

To guide the development and creation of effective interventions to reduce sedentary time among preschoolers, it also remains important to consider parenting strategies in the context of the larger family ecology (Barr, 2019). Some research suggests that boys are exposed to more screens than girls (Rideout et al., 2022). Furthermore, children with more difficult temperaments may also elicit more screen time from caregivers (Coyne et al., 2021). In terms of parent characteristics, educational attainment and distress are likely to play an important role in shaping child screen use (Hartshorne et al., 2020). The recent COVID-19 pandemic provides an opportunity to study parent mediation in the context of increased family distress. In particular, stay at home orders and disruptions to family routines led to a sharp increase in screen use during this time (Hartshorne et al., 2020; Coyne et al., 2021).

The objective of the present study is to examine how parental mediation strategies at the age of 3.5 years predict later child adherence to screen time guidelines at age 4.5 years. We examine these associations while controlling for baseline screen time, sex, and temperament and parent education and parenting stress. Given the results of prior research, we hypothesize that more parental restriction, social coviewing, and instructive mediation will each be associated with lower odds of children exceeding 1 h/day of screen time. Finally, given that previous research has found that child self-control can interact with restrictive mediation, we examine possible heterogeneity in child screen time by examining if parent use of restrictive mediation interacts with child temperamental characteristics.

Methods

Study sample

The present study employed a longitudinal correlational design undertaken to better understand the consequences of child screen media use during the pandemic. At the start of our study, children were between the ages of 2 and 5 ($N = 315$, mean age = 3.46). Follow-up took place 1 year later ($N = 265$, mean age = 4.50). Our community-based sample was recruited using convenience sampling methods. More specifically, we recruited families through preschool and

pre-kindergarten classes using posters, flyers, and signup sheets, a Facebook page, and newspaper and radio advertisements broadcast across the province of Nova Scotia, Canada. In the vast majority of cases, mothers were the primary respondent ($N = 295$, 93.4%). Our sample contained slightly more boys than girls (54 vs. 46%). Parents in our sample were mostly Canadian born (91%), married (82%), white (90.5%), and English speaking (88.1%). Parents received a 50$ gift card as compensation at each wave of data collection. Parents also provided informed consent to participate at each wave of the study. This project received ethics approval from Université Sainte-Anne and Université de Sherbrooke's internal review boards.

Data collection procedure

Parents completed the CAFÉ Assessment of family media exposure online remotely in the Spring of 2020. This assessment has been described in detail in a previous study (Barr et al., 2020). The CAFÉ assessment includes questions on child sex and screen time habits, parental education, as well as questions on parental mediation of child screen time habits. For the purpose of this study, items measuring child temperament were added to our online questionnaire. All study measures are described below.

Measures: outcomes (age 4.5 y)

Child average daily screen time. Parents completed the Media Assessment Questionnaire (MAQ, Barr et al., 2020) online, to provide estimates of the amount of time their child spent engaged in the following screen-based activities on weekdays and weekend days separately: (1) watching TV or DVDs; (2); using an iPad, tablet, LeapPad, iTouch, or similar mobile device (excluding smartphones); or (3) using a smartphone; (4) playing video games on a console; (5) using a computer. Possible responses include: (1) Never; (2) Less than 30 min; (3) 30 min to 1 h; (4) 1–2 h; (5) 2–3 h; (6) 4–5 h; (7) more than 5 h. All categorical responses were transformed into a variable reflecting the number of hours spent with each type of activity. More specifically we used the mid-point of each response range. For the category "5 or more hours a day" a conservative estimate of 5 h was used. A daily estimate for each screen-based activity was estimated by multiplying weekday estimates by 5, weekend day estimates by 2, and dividing the total by 7. We then calculated an estimate of child daily screen time by summing across all screen-based activities. A similar approach to measuring screen time has been used in previous publications (Fitzpatrick et al., 2022b; Almeida et al., 2023; Fitzpatrick et al., 2023). Finally, scores were dichotomized to distinguish children who followed recommendations (1 = ≥1 h/day) vs. those that did not (0 = <1 h/day). The same strategy was used to measure children's screen time at age 3.5 years.

Predictors (age 3.5 y)

Parental mediation practices. Parents reported how frequently they engaged in restrictive and instructive mediation and social coviewing. Items were from Valkenburg et al.'s scale (Valkenburg et al., 1999) which was created and validated to measure parent mediation strategies of child screen use. All items were rated using a Likert scale, with response options ranging from: 1 (never); 2 (rarely); 3 (sometimes); and 4 (often). Items for *restrictive mediation* include: set specific viewing hours for your child; restrict the amount of child viewing; tell your child to turn off the TV when they are watching an unsuitable program; tell your child in advance the programs they may watch; forbid your child to watch certain programs, alpha = 0.64; *instructive mediation* includes: try to help the child understand what s/he sees on TV; point out why some things actors do are bad; explain what something on TV really means; explain the motives of TV characters; point out why some things actors do are good, alpha = 0.86. Finally, *social coviewing* includes: watch together because you both like the program; laugh with the child about the things you see on TV; watch together because of a common interest in a program, alpha = 0.85.

Covariates (age 3.5 y)

Child characteristics. Parents reported child age, sex (2 = girl, 1 = boy), and temperament. Temperament was assessed using the Children's Behavior Questionnaire (Putnam and Rothbart, 2006). This instrument captures three distinct child temperament factors: effortful control, negative affectivity, and surgency/extraversion. *Effortful control* includes child inhibitory control and attention focusing (e.g., Can wait before entering into new activities if s/he is asked to). *Negative affectivity* includes measures of child anger/frustration (e.g., Child gets angry when told s/he has to go to bed). *Surgency/extraversion* reflects the child's level of shyness (reverse coded) and impulsivity (e.g., Child usually rushes into an activity without thinking about it) indicating higher levels of impulsivity and activity. Higher scores indicate higher levels of the temperamental factor. The third factor, effortful control, refers to the child's abilities to self-regulate their level of reactivity. The short version uses a 7-point Likert scale ranging from 1 (*extremely untrue of your child*) to 7 (*extremely true of your child*). The internal consistency coefficients are 0.79 for Effortful control, and 0.84 and 0.84 for Negative affectivity and Surgency/extraversion, respectively.

Parent characteristics. Responding parents completed the parenting distress subscale of the Parent Stress Index (Abidin, 2012). This measure includes 12 items that capture parent negative feelings toward their relationship with their child (i.e., I find myself giving up more of my life to meet my child's needs than I ever expected), rated on a 5-point Likert scale. Likert scale response options ranged from: 1 (strongly disagree); 2 (disagree); 3 (not sure); 4 (agree) or 5 (strongly agree). Parent responses were summed to create a total score, Cronbach's alpha = 0.85. Parents also provided information on their level of educational attainment. Responses were dichotomized as either: (1) High school or college vocational; (2) Undergraduate or Graduate degree.

Statistical analyses

We begin by conducting preliminary descriptive and bivariate analyses between our main predictor and outcome variables. To address our research objective, we first estimate a multinomial logistic regression between parental mediation strategies (restrictive and

TABLE 1 Descriptive statistics for continuous variables.

	Mean (SD)	*N*
Restrictive mediation	3.18 (0.65)	311
Social coviewing	3.07 (0.63)	311
Instructive mediation	3.13 (0.65)	308
Effortful control	4.70 (0.85)	315
Negative affectivity	3.61 (0.90)	315
Extraversion	4.27 (0.98)	315
Parenting stress	18.19 (5.60)	315

TABLE 2 Frequencies for categorical variables.

	% (*N*)
Age 4.5 y	
Screen time	
1 h or less/day	20 (53)
Age 3.5 y	
Screen time	
1 h or less/day	14 (44)
Child sex	
Girls	46 (145)
Parent education	
High school/vocational	26 (81)

instructive mediation, social coviewing) at age 3.5 years and adherence to screen time recommendations at age 4.5 years. Associations are estimated controlling for child sex, screen time, temperament, and parent education and stress. To address heterogeneity in the association between parental restrictive mediation and adherence to screen time recommendations, we add an interaction term between child effortful control and restrictive mediation which is then added to the regression model. All statistical analyses were carried out with SPSS (version 27). Consistent with previous research examining behavioral health and psychological outcomes, the alpha level was set at 0.05.

Results

Descriptive statistics and bivariate correlations

Descriptive statistics and frequencies for continuous and categorical variables are presented in Tables 1, 2. In total, 14% ($N = 44$) spent ≤1 h per day with screens at 3.5 years and 20% ($N = 52$) of our sample spent ≤1 h per day with screens at 4.5 years. Chi-square analyses revealed that adherence to guidelines at ages 3.5 and 4.5 (scored dichotomously), were positively related, with adherence at 3.5 forecasting greater adherence one year later $\chi^2(1, N = 265) = 94.13$, $p < 0.0001$. Furthermore, Kendall-Tau correlations were performed to estimate bivariate associations between continuous parent strategies and the dichotomous outcome. These analyses revealed that more restrictive mediation was associated with greater adherence at 4.5 ($r = 0.28$, $p < 0.001$) whereas social coviewing negatively associated with later adherence to screen time recommendations ($r = -0.16$, $p < 0.001$). Finally, Pearson's correlation revealed that parental mediation practices were moderately correlated with each other. Social coviewing was correlated with more instructive mediation ($r = 0.40$, $p < 0.001$) and more restrictive mediation was associated with more instructive mediation ($r = 0.26$, $p < 0.001$). Restrictive mediation was not associated with social coviewing.

Missing data

In total 84% of our sample had complete data at both time points. Children with parents with a university degree were more likely than those without to remain in our sample at the second wave, $\chi(1)2 = 4.24$ $p = 0.039$. Child sex, screen time, temperament, and parenting stress were unrelated to participant attrition. Little's test provided evidence that our data was met the missing completely at random hypothesis. As such, following best practices for treating missing data, we conducted analyses on the pooled estimates from 5 imputed data sets (Cummings, 2013).

Predicting adherence to screen time recommendations

As presented in Table 3, the logistic regression model revealed that a 1-point increase on the parental restriction scale at age 3.5 was associated with an increased odds of adhering to screen time recommendations 1 year later (OR [95% CI] = 4.07 [1.70–13.03]). In contrast, parental social coviewing was associated with an 80% decrease in the odds of meeting screen time recommendations (0.20 [0.09, 0.48]) and children exceeding screen time recommendations were 98% less likely to follow recommendations one year later (0.02 [0.01, 0.07]). Finally, children who scored higher on the temperamental dimension of negative affectivity were 51% less likely to spend ≤1 h/day with screens (0.49 [0.27, 0.87]). Instructive mediation did not contribute to child screen time nor did sex, effortful control, extroversion, and parental education and stress.

Moderation

We considered the extent to which the strength and direction of the observed association between parental restrictive mediation and adherence to screen time recommendations may differ based on child temperamental characteristics. More specifically, we examined whether the interactions of child effortful control, negative affectivity, and extraversion and restrictive mediation at 3.5 years contributed to following screen time recommendation at 4.5 years. In a second regression model, the interaction of child effortful control and parent restrictive mediation was entered as predictor. The interaction term was not significantly associated with odds of adhering to screen time recommendations (all *p*'s > 0.05 results not shown).

TABLE 3 Adjusted logistic regression estimating the probability of children meeting screen time recommendations at age 4.5 from parental mediation practices at age 3.5 (imputed data).

	Child screen time (age 4.5) (1 = follows recommendations 0 = Does not follow recommendations)	
	Odds ratio (95% CI)	*P*-value
Child sex		
Girl	0.70 (0.29–0.1.73)	0.440
Boy (reference)	–	–
Child temperament		
Effortful control	0.65 (0.34–1.26)	0.201
Negative affectivity	0.49 (0.27–0.87)	0.015
Extraversion	0.76 (0.47–1.24)	0.273
Screen time (age 3.5)		
More than 1 h/day	0.02 (0.01–0.07)	$p < 0.0001$
1 h or less/day (ref)	–	
Parental mediation		
Coviewing	0.20 (0.09–0.48)	$p < 0.0001$
Restrictive	4.07 (1.70–13.03)	0.003
Instructive	1.82 (0.82–4.02)	0.139
Parental education		
University degree	2.86 (0.75–10.90)	0.123
HS/vocational (ref)	–	
Parenting stress	1.00 (0.92–1.10)	0.935

Male is coded as 1 and female as 2. Education is coded as 0 = High school vocational, 1 = University/graduate.

Discussion

Our results indicated a low level of adherence to screen time recommendations among 3 (14%) and 4 years-olds (20%) during the COVID-19 pandemic. These estimates are comparable to other estimates collected from Canadian samples during the pandemic (Madigan et al., 2022). In the present study, we found that parental restrictive mediation, which involves behaviors like establishing specific viewing hours for the child or restricting how long they can view screen media, was associated with a 4 times greater chance of respecting the recommendation of ≤1 h of daily screen time. This association was observed in the context of the pandemic, above and beyond child sex and baseline screen time, temperament, and parental education and stress. Since the pandemic represented a time of increased strain and distress for families, replications are warranted to examine the extent to which parental restrictions as well as instructive mediation and co-viewing may contribute to child screen time under more typical circumstances.

Unlike previous research (Lee, 2013), we did not find evidence of an interaction between child effortful control, extraversion, and negative affectivity on later screen time. This suggest that restrictive approaches may be an effective strategy with young children, regardless of their temperamental characteristics and family context. Although child temperamental characteristics did not modify the association between parental restrictive management and later child screen time, child negative reactivity was associated with more screen time at the age of 3. This finding supports previous studies indicating that children with more challenging behaviors at age 3 are likely to be exposed to more screen time by the age of 5 (Neville et al., 2021).

In the present study, instructive mediation, which involves discussing the contents of screen media to stimulate critical thinking, was not related to child screen time habits. This may be the case because instructive mediation contributes to positive outcomes mainly in older children and adolescents as they become better able to think critically and self-regulate their behaviors (Nathanson, 2002; Fu et al., 2020). Furthermore, discussing the actions and motives of characters may exercise a protective effect when children are viewing traditional television programs but less so when they are using a tablet or mobile device for other types of activities. Social coviewing, which involves parents and children sharing the screen viewing experience without attempts to critically discuss the contents, reduced the chances of following the recommendation. A possible explanation for this finding is that coviewing of media with parents may be perceived as a parental endorsement of screen time, whereas restrictive mediation may be perceived by children as parental disapproval of screen media viewing (Nathanson, 2001).

The preschool years may present a window of opportunity during which restrictive practices may be especially effective. That is, self-control develops rapidly during the preschool years and is likely to benefit from parental scaffolding in the form of preestablished rules and routines. In contrast, the use of restrictive mediation may backfire with older children (Nathanson, 2002). For instance, a study of adolescents whose parents used restrictive mediation of their television viewing reported more positive attitudes towards television content.

Future research could attempt to better understand which factors contribute to parent's use of restriction and rule setting surrounding their child's screen use. Previous research has found that parents' attitudes towards screen media, media literacy, and beliefs surrounding the impact of screen media on their child's behavior are related to media rule setting (Vandewater et al., 2005; Lee, 2013). As such, these parental variables may represent promising intervention targets.

There is evidence that home-based interventions can be effective for helping parents modify routines and improve health habits (Haines et al., 2013). Interventions such as Healthy Habits, Happy Homes, which uses motivational interviewing and individually tailored counseling by health educators to encourage behavior change has been used to reduce the risk of obesity in at-risk American families. Incorporating a screen use mediation component to home visits may further help parents manage their child's screen use and increase health promoting behaviors. In particular, interventions could be designed to help parents implement goals and follow a schedule that restricts child screen use.

Several limitations should be discussed. First, the present findings are based on a low-risk, convenience sample facing low levels of sociodemographic risk. As such, replications with larger, more diverse samples are warranted. Our findings are also potentially limited by shared informant bias since parents provided data on media management strategies and child screen time. In terms of strengths, our study was able to examine prospective associations between parent screen mediation strategies and later child adherence to screen time recommendations, above and beyond pre-existing screen time. As such, this study also helps identify modifiable parent-level protective factors for following screen time recommendations.

In conclusion, our results indicate that parent rule and limit setting, but not active forms of mediation that involve coviewing or discussing screen media with preschools, may help children develop healthy media habits. Furthermore, parental restriction appears to be effective above and beyond child screen time habits and child and parent risk factors. Better understanding how naturally occurring real world parental behaviors contribute to child media habits is helpful for designing effective ecologically valid interventions.

Data availability statement

The data presented in this article are not readily available. As per the participant consent form, data are only available to the research team. Requests to access the data should be directed to caroline.fitzpatrick@usherbrooke.ca.

Ethics statement

The studies involving humans were approved by Comité d'étique de l'Université de Sherbrooke. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent to participate in this study was obtained from the participants' legal guardian/next of kin.

Author contributions

EC: Validation, Writing – review & editing. JB: Methodology, Writing – review & editing. GG-C: Conceptualization, Formal analysis, Writing – review & editing. CF: Conceptualization, Formal analyses, Writing – review & editing, Secured funding.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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Do parent media habits contribute to child global development?

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Background/objective: Parents of preschoolers' report using screen media frequently. More frequent screen use by parents may undermine child development by displacing time for foundational parent-child interactions. The objective of the present study is to examine the extent to which parent screen use contributes to child global development 1 year later.

Methods: Data are from a cohort of 315 preschoolers from Nova Scotia, Canada and their parents during the COVID-19 pandemic. Parents reported the number of hours per day they spent using screens, as well as child screen time and sex, and parent educational attainment. Our outcome is child global development scores, which combine assessments of communication, cognitive, personal-social, and motor skills measured at 4.5 using the *Ages and Stages Questionnaire* (ASQ) (N = 249, 79% retained).

Results: Parents in our sample spent on average 6.35 h per day using screen media outside of work (SD = 3.07) and children spent on average 3.43 h per/day using screens. Multivariate linear regression indicated that each 1-h increase in parents daily screen media use, corresponded to a 1.25 decrease in child global development scores, $B = -1.25$ $p < 0.05$, 95% CI between −2.37 and −0.13.

Conclusion: Our results indicate that parent screen use may represent a key component of children's media ecology. Given the importance of global development in early childhood for later health and achievement, the present results suggest that interventions should include parent screen use habits in media wellness interventions.

KEYWORDS

parent media use, parent screen use, global development, ages and stages questionnaire, preschool, early childhood

1 Introduction

Screen media, referring to content that is available through electronic devices such as televisions, computers, phones, and tablets, has infiltrated young children's personal and family ecologies (Rideout and Robb, 2020). The impact of accumulating too much screen time by preschool-aged children on their health and development have been previously demonstrated with studies indicating that child screen time can undermine their brain development, sleep, and fitness (Pagani et al., 2010; Jones et al., 2013; Lan et al., 2020). Research also suggests that screen time can undermine global child development across motor, communication, cognitive, and personal/social domains, and increase risks for developmental delays (Madigan et al., 2019). Global child development is a key predictor of school readiness and early achievement (Prior et al., 2011; Józsa et al., 2022). Research has found that one out of every four child is at risk of beginning kindergarten without the requisite skills set to success (Browne et al., 2018). Given the omnipresence of screens in children's ecology, better understanding how screens in children's early environments contribute to global development remains crucial.

According to ecological theories of child development, parental screen time is also of concern (Barr, 2019). One study conducted prior to the pandemic found that mothers of 3-year-olds spend 3 h per day using screen media (Madigan et al., 2020). More recently, during the COVID-19 lockdowns, parents of preschoolers reported spending as many as 6 h per day of personal screen time (Fitzpatrick et al., 2022). This may be the case because the pandemic and its accompanying confinement measures led many families to become more reliant on screens for daily activities and socializing.

According to one review, parent screen time can distract parents and lead them to be less verbally and non-verbally responsive to their child (Kildare and Middlemiss, 2017). Furthermore, another review suggests that parent mobile devise use can reduce parent sensitivity toward their child (Braune-Krickau et al., 2021). As such, to more fully understand how children's media ecology is shaping their development, it remains important to also consider whether parent screen use may have an impact on young children's development.

Early childhood represents a key developmental window for acquiring key cognitive, motor, and social skills. Young children, in particular, depend on sensitive, warm, and reciprocal interactions with caregivers to acquire foundations skills across these domains. Existing research has examined how parent mobile device use and attitudes toward technology relate to child media habits (Cingel and Krcmar, 2013; Lauricella et al., 2015; Pila et al., 2021). However, to date, few studies have examined how parent screen use contributes to children's later developmental skills. One exception is a longitudinal study that followed parents of children ages 1–5 and found that parental distraction with technology is associated with an increased risk of children developing behavioral problems, including emotional reactivity, tantrums, withdrawal, and anxiety (McDaniel and Radesky, 2018). Research has yet to examine how parent screen time may influence global child development across motor, social, and cognitive domains.

The COVID-19 pandemic was accompanied by increases in family screen media use (Hartshorne et al., 2021). As such, it remains useful to examine parent screen use habits and their consequences during this challenging time. In addition, most research on this topic has been cross-sectional and conducted with infants and toddlers. As such, little is known about the potential impact of parental screen use on children during the preschool years. Finally, previous research has found that family screen use and child global development are associated with child and family characteristics including child sex and screen time, socioeconomic status, and access to financial and personal resources (Dohnt and Tiggemann, 2006; Cingel and Krcmar, 2013; Lauricella et al., 2015; Kildare and Middlemiss, 2017; McDaniel and Radesky, 2018; Madigan et al., 2020; Braune-Krickau et al., 2021; Hartshorne et al., 2021; Pila et al., 2021; Fitzpatrick et al., 2022; Rideout et al., 2022). Thus, the objective of this longitudinal study is to better understand if parental screen use is associated with preschooler global development. We hypothesize that greater parent screen use will forecast lower child global development scores. To better isolate the potential contribution of parent screen use, we estimate associations while statistically controlling for child sex and baseline screen time and parent education.

2 Materials and methods

2.1 Sample and procedure

This 2-year longitudinal study followed parents (N = 315) and their preschool-aged children (mean age = 3.46, age range between 2 and 5). The baseline data collection took place between April and August 2020, during the first wave of the COVID-19 pandemic and a provincially declared state of emergency, in Nova Scotia, Canada. Participants were recruited using multiple strategies including through posters and pamphlets distributed in daycares and schools, and family clinics, as well as through advertisements in the newspapers and broadcast on the radio across Nova Scotia. Mothers were the respondents in 94% of cases. Most participants reported they were married (82%), born in Canada (91%), and white (90.5%). Of the sample, 53% of the children were male (N = 168) and 47% were female (N = 147). The majority of participants reported that English was the most spoken language in their home (88.1%). To measure the child and parent screen time, participants were asked to complete an online questionnaire when children were 3.5 years old. One year later, when children were 4.5 years old, parents rated child global development (N = 249,79% retained) remotely. Parents were compensated for their time with a 50$ gift certificate at each data collection. Parents also provided informed consent to participate at each wave of the study. This project received ethics approval from Université Sainte-Anne and Université de Sherbrooke's internal review boards.

2.2 Measures: outcomes

Parents completed the Ages and Stages Questionnaire third edition (Squires et al., 2009) to assess 5 areas of child development:

Communication; Fine motor skills; Gross motor skills; Problem-solving; and Personal/social development. In total, parents answered 30 statements (6 questions per domain of development) on their child's ability to perform a task. Response options were: (1) Yes, scored as 2; (2) Sometimes, scored as 1; or (3) Not yet, scored as 0. A global development score was computed by summing the scores across all domains of development. The ASQ screening tool is routinely used in clinical settings to screen for developmental delays (Richter and Janson, 2007). The validity, sensitivity, reliability, and specificity of this scale have been demonstrated in several studies (Gollenberg et al., 2010; Schonhaut et al., 2013; Singh et al., 2016). To account for the range in child age in our sample, we computed age-adjusted scores by subtracting the age normed clinical cut-off from each child's score. As such, negative scores reflect that a child was below their clinical cut-off whereas a positive score indicates that a child was above their clinical cut-off.

2.3 Measures: main predictor

Parents completed the Media Assessment Questionnaire (MAQ) (Barr et al., 2020) to provide estimates of the amount of time they spent engaged with the following devices on weekdays and weekend days separately, outside of work hours: TV/DVD, computer, video games consoles, iPad, tablet, and smartphone. Response options included: (1) Never; (2) Less than 30 min; (3) 30 min to 1 h; (4) 1–2 h; (5) 2–3 h; (6) 4–5 h; (7) more than 5 h. We then converted these categorical responses into continuous variables reflecting the number of hours spent with each type of media. Our approach involved using the midpoint for each response range, with the exception of "5 or more hours a day" where a more conservative score of 5 was used. Daily weighted estimates were then estimated by multiplying weekday estimates by 5 and weekend day estimates by 2 and dividing the total by 7. Finally, we calculated an overall daily screen time estimate by summing average daily usage across media devices.

2.4 Control variables

Parents also reported child media use using the MAQ. More specifically, parents reported the average amount of time children spent doing each of the following on weekdays and weekend days separately: (1) watching TV or DVDs; (2) using a computer; (3) playing video games on a console; (4); Using an iPad, tablet, LeapPad, iTouch, or similar mobile device (excluding smartphones); or (5) Using a smartphone. Response options included: (1) Never; (2) Less than 30 min; (3) 30 min to 1 h; (4) 1–2 h; (5) 2–3 h; (6) 4–5 h; and (7) more than 5 h. We then used the same approach as used with the parent screen time measure to create a weighted daily estimate of child screen time. Finally, we calculated an overall daily screen time estimate by summing average daily usage across media devices. Parents also reported child sex, and their educational attainment which was dichotomized as either: (1) High school or college vocational (N = 81); and (2) University degree (N = 234).

TABLE 1 Descriptive statistics for continuous study variables.

	Mean (SD)	*N*	*N* (% missing)
Age 3			
Parent screen time	6.35 (3.08)	315	0
Child screen time	3.43 (2.44)	315	0
Age 4			
Global development	112.54 (32.48)	250	66 (21%)

TABLE 2 Frequencies and proportions for categorical variables.

	N (%)	*N* (% missing)
Parent educational attainment		0
High school/college	81 (25.60%)	
University degree	234 (74.10%)	
Child sex		0
Male	168 (53.20%)	
Female	146 (46.20%)	

TABLE 3 Bivariate correlations between parent media use and child developmental outcomes.

	1	2	3
Predictors			
1. Parent ST	–	0.45***	−0.18**
2. Child ST			−0.13**
Outcomes			
3. Global development		–	–

ST, screen time. **$p > 0.01$, ***$p > 0.001$.

3 Results

3.1 Descriptive and bivariate statistics

Descriptive statistics and frequencies are presented in Tables 1, 2, respectively. Table 3 shows bivariate associations between parent and child screen time and later child global development. Parents and children in our sample spent on average 6.35 (SD = 3.07) and 3.43 (SD = 2.44) hours per day using screens, respectively. Girls performed better than boys on the assessment of global development (mean = 120.52 vs. 105.62). In general, there were very few children that did not meet the global development clinical cut-off (1.2%). Overall, for each domain few children met the clinical cut-off for developmental delays in gross (4.8%) and fine (4.4%) motor, personal/social (4.4%), communication (2.4%), and problem solving (1.2%) domains of development. Bivariate correlations indicated that parent screen time ($r = -0.18$, $p < 0.01$) and child screen time ($r = -0.13$, $p < 0.01$) were both significantly negatively correlated with child global development scores. Furthermore, in terms of the sub-domains of global child development, parent screen time was significantly negatively

TABLE 4 Adjusted unstandardized regression coefficients estimating the contribution of parents and child screen time to global child development.

	Global development	
	B (95% CI)	*P*-Value
Parent screen time	−1.25 (−2.37 το −0.13)	0.029
Child screen time	−1.05 (0.67 το 0.01)	0.293
Child sex		
Girl	14.71 (8.51 to -20.93)	<0.001
Boy (reference)	–	–
Parent education		
Bachelors/graduate	−1.58 (−8.84 το 5.69)	0.670
HS/vocational	–	–
R square	0.09	

Results are adjusted for child screen time, child sex, and parent education.

associated with child communication ($r = -0.15$, $p < 0.05$), gross motor development ($r = -0.13$, $p < 0.05$), and problem solving ($r = -0.18$, $p < 0.01$).

3.2 Missing data

In total 79% of our sample had complete data at both assessments when they were 3.5 and 4.5. Children with parents with a university degree were more likely than those without to remain in our sample at the second wave, χ (12) = 5.37 $p = 0.020$. Child sex and screen time were unrelated to participant attrition. Little's test conducted in SPSS was non-significant, which provides evidence that our data was MCAR, χ (12) = 16.43, $P = 0.172$. As such, following best practices for treating missing data, we estimated 5 imputed data sets using the multiple imputation function in SPSS and conduct our analyses over these pooled estimates (Cummings, 2013).

3.3 Multiple regression analyses

Regression results are presented in **Table 4**. An adjusted multiple regression was estimated to measure associations between parent screen use when children were 3.5 and global child development when the child was 4.5. Child's own screen time, sex, and parent education were controlled. Analyses revealed that each 1-h increase in parents daily screen use corresponded to a 1.25 decrease in child global development scores, ($B = -1.25$ $p < 0.05$, 95% CI between −2.37 and −0.13). Practically, our results suggest that an average of 6 h of parental screen time daily would correspond to 1.86 and 7.5 score reductions global development scores. As such, associations indicate that parental screen time could account for decreases in approximately 23% of a standard deviation.

4 Discussion

In the present study, we examine whether parental screen time when children were 3.5 was predictive of later global child development at age 4.5. In support of our hypothesis, we found that the number of hours parents spent using screens was associated with lower child global development scores 1 year later. Each of these in turn is considered a key determinant of children's ability to successfully transition to and benefit form, school-based learning at the time of kindergarten entry (Duncan et al., 2007; Grissmer et al., 2010).

Our research adds to the literature by suggesting that more frequent and lengthy parent screen use may represent a risk factor for poorer developmental outcomes in preschoolers. According to ecological theories of development, learning in the early years is highly dependent on the social environment of the child and in particular, their interactions within their microsystems (Barr, 2019). The intensive use of screen media by parents is likely to interfere with the timing of these interactions by occasioning distractions. For instance, according to one study of mothers with children aged 3 or less, screens had disrupted parent-child interactions for 65% of the sample during playtime, 36% during book reading, 26% during mealtime, 26% during bedtime, and 22% while setting limits or disciplining the child (McDaniel and Coyne, 2016).

Similarly, our findings are consistent with the *displacement hypothesis*. The preschool years are crucial for experience-dependent learning. Accordingly, too much time devoted to screens by parents may limit the amount of time they are able to allocate to enriching activities that could help support child global development across physical, cognitive, and social domains.

Studies have also found that screen use by parents may reduce the amount of learning support provided to children. More specifically, parental mobile device use may interfere with scaffolding (i.e., providing timely feedback to the child), joint attention (ex. coordinating attention on the same object as the child), directiveness (ex., providing verbal and non-verbal directives to the child) (Corkin et al., 2021; Ochoa et al., 2021). Furthermore, according to the same studies, parental mobile device use was associated with lower child vocabulary. In line with these results, another observational study found that mothers who spontaneously used their mobile devices during a structured laboratory task initiated less verbal and non-verbal interactions with their preschool-aged child (Konrad et al., 2021).

In addition to disrupting dyadic parent-child interactions, parents also report that screens including cell phones/smartphones, television, computers/laptops, and iPads or other tablets interfere with coparenting, especially during activities like child play (McDaniel and Coyne, 2016). According to the same study, mothers who reported more interference from screens reported worse relationship satisfaction with their partners, and higher levels of depressive symptoms. As such, future research could seek to clarify the role that parental relationship quality and mental health may play in the association between parent screen use and child global development.

The present study presents some strengths. First, our study is the first to examine links between parent screen use outside of work and later global development in preschoolers. Furthermore, our study allows us to shed light on these association using a prospective study design implemented during the COVID-19 pandemic.

In terms of limits, our study was conducted remotely, due to public health measures in place at the time of data collection.

As such, it was not possible to directly observe parent's use of screens and account for extent to which parents might have been using screens in the presence of their child, and the extent to which parental screen use may have been disruptive to parent child interactions. Second, our study relies on a relatively homogenous, low risk convenience sample. Replications with families facing higher levels of socioeconomic adversity are warranted. Lastly, in the present study we did not consider work-related screen use, which could additionally contribute to child outcomes. Even though we found prospective associations between parent screen use and preschooler global development, it was not possible to control for baseline measures of child global development or address the possibility of reverse causation since our outcome measurement was only administered at our follow-up assessment. As such, studies using repeated measures of child global development could help clarify the extent to which parent use of screen media may contribute to children's developmental characteristics above and beyond their baseline global development.

Future studies could shed light on parent characteristics and the nature of their screen use that may contribute to child outcomes. For instance, mothers more often divide their attention between their device and their child, whereas fathers are more likely to remain more continuously focused on their phone (Kiefner-Burmeister et al., 2020). Research could clarify the extent to which additional parent characteristics (ex., mental health) contribute to screen use and child outcomes. The nature of parents' screen use is also likely to represent an important moderator in the association between their screen habits and their interactions with their child. For instance, studies have found that parents interact more and show more engagement toward children when taking a picture, then when texting or swiping (Bury et al., 2020). Research has found that the most popular activities observed during parent phone use are texting or swiping (43%), looking at the screen (22%), making calls (22%), and taking pictures of the child (Ochoa et al., 2021). As such, research could seek to better understand which parental screen use activities are likely to interfere with ongoing parent-child interactions and those that are least likely to interfere.

To date, most pediatric societies have focused on sensitizing parents to the potential of consequences of excessive screen use by children with little or no attention given to parent screen use. The present findings suggest that parents of young children should be encouraged to limit their screen time to ensure optimal developmental outcomes in early childhood. Our results also suggest that parent-child interactions may be a promising intervention target for reducing or minimizing harms occasioned by family screen use. Intervention efforts could aim to sensitize parents about their own screen habits and their potential impacts on child developmental outcomes. Furthermore, our results suggest that parents should be encouraged to prioritize screen free activities with children like imaginary play, physical activities, and shared book reading to help foster strong global development skills. This remains all the more important in the context of widespread family screen use in the ecology of young children.

Data availability statement

The data for the present study are not readily available. As per the participant consent form, data are only available to the research team. Any requests for the raw data should be addressed to the coresponding author.

Ethics statement

The studies involving humans were approved by the Université Sainte-Anne Comité d'Étique. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

CF: Conceptualization, Data curation, Funding acquisition, Methodology, Project administration, Writing – original draft. AJ: Formal analysis, Methodology, Writing – review and editing. AL: Writing – review and editing. MB: Writing – review and editing. EH: Conceptualization, Formal analysis, Supervision, Writing – review and editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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Familial context influences media usage in 0- to 4-year old children

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Background: The use of digital media (e.g., smartphones, tablets, etc.) and the Internet have become omnipresent for every age group and are part of children's and parents' everyday life. Focusing on young children, the availability of media devices, their use as well as associated problems (e.g., in social, emotional and motor development) have increased in recent years. Of particular interest for prevention of these problems in early childhood is the relationship between the familial context (parental digital media use, Problematic Internet Use, school graduation, presence of siblings) and the digital media use of infants and toddlers. The present study's goal was to describe media usage in 0–4-year-old children and to identify the potential relationship between familial context factors and child media usage.

Methods: The sample included $N = 3{,}035$ children aged 0 to 3;11 years ($M = 17.37$ months, $SD = 13.68$; 49.13% female). Recruitment took place within the framework of a restandardization study for a German developmental test. The parents of the participants answered a questionnaire on socio-demographics, on child media use, and on parental media use. Questions on parental media use included the full version of the Short Compulsive Internet Use Scale (S-CIUS).

Results: Significant increases in media usage times with child age were identified, but no significant gender differences. A multiple regression analysis revealed that increasing maternal total media usage time, a higher parental S-CIUS score, lower school leaving certificate of both mother and father, and increasing child's age led to higher child media usage time. Having siblings diminished young children's media usage in this study. Having more than one child and having children aged over a year was associated with a higher parental S-CIUS score.

Conclusion: Family factors such as maternal media use time, Problematic Internet Use and lower school graduation are significantly associated with young children's digital media use. Parents should be aware of their personal influence on their children's media use which might be due their role in terms of model learning.

KEYWORDS

parental media usage, children's media usage, family factors, Problematic Internet Use, familial context, young children

1 Introduction

These days, children and adolescents grow up in homes with media like television, smartphones, computers, tablets, smart watches and gaming consoles being highly present and used, further reinforced by the COVID-19 pandemic (1–9). Due to the progressing digitization, children and adolescents as well as their parents, caregivers, teachers, therapists and doctors are being confronted with new issues and disorders arising from this development like Gaming Disorder (10–13), Internet Addiction or Problematic Internet Use (14–16). As nosology currently cannot keep up with the rapid technological development of digital hardware and applications over the last two decades, literature uses various terms for describing this clinical entity. This results in a multitude of different and partly conflicting conceptualizations of digitization-related disorders with different diagnostic criteria and test procedures.

Excessive media usage can influence a child's or adolescent's development in a way that prevents usual developmental tasks or milestones from being reached. The foundations for functional or dysfunctional and impairing media consumption are not laid in adolescence or childhood, but in preschool, toddlerhood and infancy. Especially social, emotional, cognitive, verbal and motor skill development as well as nutrition and sleep are negatively affected by early digital media usage (17–23). Time spent with using digital media devices can displace the time usually spent with parents or other family members (24) and result in multiple negative consequences (e.g., impaired language and executive functions, impaired caregiver-child relationship, anxiety, behavioral difficulties, cardiovascular risk) especially for infants and preschool children (25–29). Additionally, an increasing amount of parents are using mobile devices as distractions while with their children, resulting in a lack of parenting responsiveness and quality (30, 31). This leads to the assumption that „digital native" parents are engaging in media use behaviors that affect their children's development, as well as their own sensitivity (32, 33) toward their child, especially in the first year of life. Additionally, parental media use during parent–child-interactions (technoference) may influence the child's externalizing and withdrawal behavior (34) and may lead to "maladaptive technological behaviors" (35).

Currently, the age at which children start using media is shifted to preschool age and infancy (24), partly because of the new interactive media devices (36) accompanied by touch screens' simplified handling and voice control (37). As a result of market development and technical innovations, usage times have skyrocketed, with young children being specifically and more intensely targeted as consumers.

In order to be able to possibly prevent or reduce young children's media usage, it is essential to understand which contextual conditions contribute to this problem. Models that aim to explain the development of Gaming Disorder, Problematic Internet Use or other disorders that are related to digitization are multicausal and include internal factors like structural and functional neurobiological abnormalities, executive disorders and comorbid psychological disorders as well as external (parental modeling of how to interact with media) and social factors (family's socioeconomic situation) (12, 38–40).

Since young children are reliant on their parents for a plethora of things it makes sense to investigate the familial context when addressing influences on children's usage of media and screen time.

Generally, children's media usage patterns have been reported to be similar to their parents' (41): parents who consume a large amount of media themselves are more likely to raise children who are exposed to and use media early on than parents with a more reserved approach to media usage.

Parents' socioeconomic status has been linked to young children's media usage: Children in lower educated, lower income families are reported to have more devices in their bedroom and spend more time using media than children whose parents have a higher socioeconomic status (41–44).

Looking at parents separately as individuals, several studies take the mother's education into account [e.g., (45, 46)]. Rideout and Hamel (43) report that young children with mothers who have not finished a high school education spend more time in front of a screen on a daily basis than children whose mothers have obtained a higher level of education. In line with these findings, Anand and Krosnick (47) found that mothers' lower education resulted in more TV watching in children between 6 months and 6 years, with the same result found for fathers. Hoyos and Jago (48) report that both parents' common education level is moderately negatively associated with screen-time while fathers' education level shows a strong negative correlation with children's screen-time.

While some research suggests that young children who have siblings are more likely to engage in daily media use than only children are (49), other research has not been able to replicate these effects (41). Children with siblings as well as their families might engage in more activities that are alternatives to media and screen time than families with only children do. This could imply that children who do not have siblings might spend comparatively more time using media and more time in front of screens than young children who have siblings. The effect that having siblings may or may not have on young children's media usage is one that has been yielding inconclusive results. De Decker et al. (50) conducted a qualitative interview-study in 6 European countries and found, that parents in Bulgaria, Germany and Spain believe that siblings or friends have a major influence on children's screen time whereas the attitudes of parents from Greece, Poland and Belgium were inconclusive. The conflicting findings found in the literature may be due to the influence of the age of siblings, as older siblings might be seen as role models and might have a stronger influence on the media usage behavior than siblings of the same age. Moreover, gender differences could also influence the relationship between siblings and digital media use, as mentioned by Bagley et al. (51).

In line with developmental progress, age overall is strongly positively associated with screen time in young children (48). Older children are reported to have a higher media consumption than younger children and it can be considered confirmed that a child's age generally is a significant predictor of their usage of media (47).

With regard to gender differences, studies note that there is a preference for gaming among boys and a preference for social media use among girls (52, 53). Regarding younger samples, Green et al. (54) also found gendered differences in the time spend on video game usage. In a longitudinal study spanning 3 years with children of the ages 2 and 4 at the start, they found that boys spend more time playing video games than girls and that these differences increase with age. In line with this finding, a nationwide survey conducted by Ofcom in the United Kingdom in 2014 (55) showed that 30% of boys aged 3 to 4 use a games console, but only 21% of girls aged 3 to 4. The

miniKIM-Studie (6) however does not find any significant gender differences in two- to five-year-old children. It is to be explored whether gender differences may not yet be so pronounced at this early age. Findings on gender differences in younger children and infants are lacking, as is research on gender differences in general digital media use time in this age group.

All these afore mentioned factors have been shown to have some effect on children's and adolescent's media behavior. However, it is still unclear in many ways to what extent this applies for young children as well. In addition, reciprocal relationships between children's and parents' media use could also be possible, in the sense that even young children could have an influence on parental media use. Obtaining more data seemed necessary to identify patterns that might result in or from young children's media usage.

Therefore, in this study, we hypothesize that media usage in children aged 0 to 4 is predicted by familial context. More specifically, our first hypothesis is that parents' increased media usage time and parents' Problematic Internet Use are positively correlated with their young children's time spent using media. An associated research question to be answered by this study is whether there is a reciprocal relationship between child characteristics and parental media use in the sense that child variables could influence parental media use, too. Hypothesis 2 states that parents level of education is a predictor for the amount of time children use media: higher level of education is associated with less time using digital media. The third hypothesis postulates that a child's age positively predicts their media usage time: The older the child, the more it uses digital media.

Concerning the mixed results regarding siblings and their influence in research so far, a research question we aim to answer in this study is how the presence of siblings affects young children's media usage.

2 Materials and methods

2.1 Study design

The sample was recruited within the framework of a restandardization study for the Münchner Funktionelle Entwicklungsdiagnostik (MFED), consisting of a prospective cross-sectional study. The preparation for the restandardization study project (MFED) started in 2015. The associated media study reported in this paper was prepared from January 2019, and data collection took place from May 2019 to March 2022. This study is monocentric, being conducted by the Chair of Social Pediatrics at the Technical University of Munich, and the kbo Kinderzentrum München.

The aim of the study was to carry out the investigations throughout Germany. The distribution is as follows: 58.6% Bavaria, 21.0% Berlin, 5.6% North Rhine-Westphalia, 4.9% Baden-Württemberg, 2.5% Thuringia, 2.4% Saarland, 2.0% Saxony-Anhalt, 1.3% Lower Saxony, 0.8% Bremen and 0.3% Saxony. 0.8% of the children were examined in Innsbruck (Austria).

Participating families were recruited in pediatrician's practices, hospitals, daycare centers/preschools, and through the distribution of flyers in playgrounds, counseling centers, etc. The children, accompanied by their parents, were invited to participate in the study by the examiners.

The questionnaire was completed by the parents at home or during the child's developmental examination. All participants' parents were informed and asked for written consent for participation in the study.

2.2 Participants

The sample used for our study included children aged from a few days postnatal age to 3 years and 11 months whose development had been normal up to that point.

Exclusion criteria were as follows: prematurity (birth weight under 1,500 g), a mother tongue different from German, medication impacting children's cognitive or verbal performance as well as sensory or motor disabilities. Illnesses with a heightened risk of developmental disorders or genetic disorders were also excluded. No people who in any way were dependent on the director of studies or doctor/scientist responsible for this study were included.

The original *ad-hoc* sample consisted of 3,126 children. 12 (0.38%) had to be excluded because of missing values in total media usage time, 27 (0.86%) had missing values in S-CIUS and therefore became ineligible for further analysis and 24 (0.77%) children had to be excluded because of missing values in the total media usage time of their mother and father. Lastly, 28 (0.90%) data sets were excluded as outliers (participants were excluded as outliers in the multiple regression analysis (3 *SD* or more, based on standardized residuals)), so the final sample consists of 3,035 participants, 97.09% of the original sample. The participants flow can also be found in Figure 1.

2.3 Measures

The questionnaire on socio-demographics and on media usage, times of use and contexts of use of children aged 0–4 years and their parents is a questionnaire developed by the Child and Adolescent Psychiatry, Saarland University Hospital in cooperation with the Technical University of Munich in 2019. The questionnaire contains 57 items and was designed to assess general information, such as demographic information, school leaving graduation of mother and father as well as leisure activities and contexts of use and times of use of electronic media (e.g., television, computer/laptop, smartphone, smartwatch, tablet, game console) in children and parents.

Information about the child (10 items; e.g., gender, number of siblings, position of the child in the family, illnesses) and the child's living circumstances (1 item, single-choice; e.g., living with both biological parents; see Table 1) are asked. Furthermore, the questionnaire asks whether the child attends a nursery/kindergarten and whether digital media are used there (dichotomous response format; yes/no), whether the child is in a club, and which activities the child likes (open response format). The questionnaire asks which media devices are available in the household (e.g., Smarttoy; see Table 2), which devices the child uses on a daily basis (open response format) and looks at how much time is spent with them (on average per day; indicated in minutes; see Table 3) as well as in which contexts (e.g., for the child's occupation, at mealtimes, during waiting times, etc.; see Table 4). The questionnaire also asks whether the child can freely dispose of his or her media time, whether he or she has free

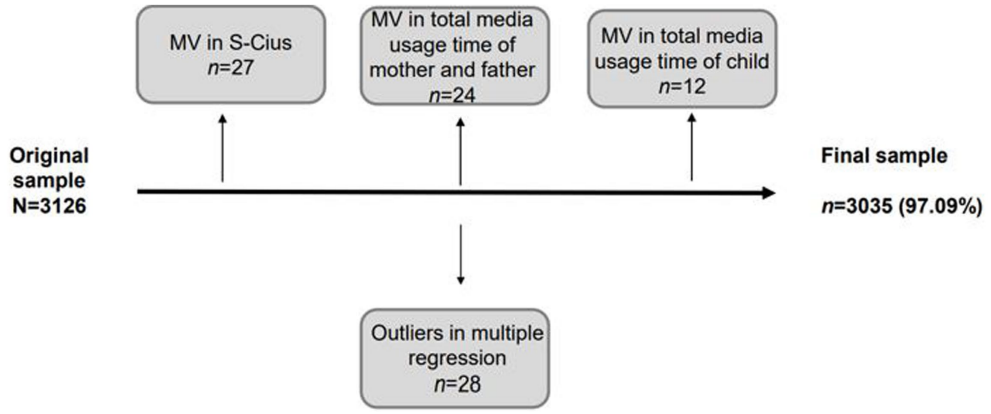

FIGURE 1
Flow of participants. MV, missing value. Participants were excluded as outliers in the multiple regression analysis (3 *SD* or more, based on standardized residuals).

access to the internet and whether safety locks have been installed (dichotomous response format; yes/no).

Information about the highest school-leaving graduation (e.g., High School, University; see Table 1) of the biological parents are asked.

Additionally, the parents' media consumption is recorded in detail, in particular how much time mother and father spend per day on average with different screen media (see Table 5). The Short Compulsive Internet Use Scale (S-CIUS) (56) is a short form of the Compulsive Internet Use Scale (CIUS) (57) and embedded in the above-mentioned questionnaire. It's a screening tool to assess Problematic Internet Use (PIU). It consists of 5 of the original 14 items rated with a five-point Likert scale. The items are as follows: "How often do you find it difficult to stop using the internet when you are online?", "How often do other people (parents, friends) say you should use the internet less?", "How often do you sleep too little because of the internet?", "How often do you neglect your daily obligations because you prefer to go online?" and "How often do you go online when you are feeling down?". The response options for each are "0 = never, 1 = seldom, 2 = sometimes, 3 = frequent, 4 = very frequent". Its reliability of 0.77 (Cronbach's Alpha) is adequate. At a cut-off of 7 which was shown to perform best in case detection, it yields a sensitivity of 0.95 and a specificity of 0.87 (58). In all these psychometric properties it is no worse than its full-length version.

2.4 Statistical analysis

The contents of the study were evaluated descriptively and via inferential statistics. A multiple regression analysis was conducted to predict the child's total media usage time. To compare the effect of age group (children) on Problematic Internet Use (S-CIUS total score) (parents) a one-way ANOVA was performed. Because of the violation of the preconditions (such as homoscedasticity and normal distribution) and unequal group sizes, a Brown-Forsythe ANOVA was calculated. Additional t-tests were performed for group analysis of continuous variables. Since the requirements for a t-test for independent samples were not met, a Mann Whitney U Test was calculated.

Data were analyzed using the IBM SPSS Statistics version 26. A significance level of 0.05 was used for all statistical tests.

3 Results

3.1 Descriptive analysis

3.1.1 Sample

The participants' mean age was 17.37 months (*SD* = 13.68, Min. = 0, Max. = 47) with 1,544 (50.87%) of them being male and 1,491 (49.13%) being female. The average maternal age at birth was approximately 32 years (*SD* = 4.73, Min. = 14, Max. = 52). The average paternal age at birth 35.16 years (*SD* = 5.76, Min. = 15, Max. = 67). 93.40% of the questionnaires were filled out by the mother alone or by the mother with another person (e.g., father/new partner). At the time of data collection 2,843 (93.67%) children lived with both of their biological parents. In case of the biological parents being split up, most children lived with their mothers and not their fathers. Only 10 (0.33%) lived in foster families or with adoptive parents. 1,690 (55.68%) had at least one sibling while 1,345 (44.32%) were only children. 2038 of the mothers (57.15%) had graduated university or a finished high school education, 31.25% finished secondary or intermediate secondary school, and 0.92% had none or a special school certificate. Among fathers, 62.27% had graduated university or a finished high school education, 34.96% finished secondary or intermediate secondary school, and 1.25% had none or a special school certificate (see Table 1).

3.1.2 Media characteristics by household and child

The *media devices available in the household* can be found in Table 2. The most owned items used for consuming electronic media among families were smartphones (93.44%), televisions (87.55%), laptops (84.09%) and tablets (61.48%). Consoles were present in 24.65% of households.

Tables 2, 3 show the children's media behaviors, such as total *daily media usage time* in minutes as well as daily media usage time categorized by media type. Out of 3,035 children, about half of them

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TABLE 1 Sample characteristics.

Characteristic	*M*	*SD*
Siblings	***n***	**%**
Single child	1,345	44.32
Has siblings	1,690	55.68
1	1,198	39.47
2	374	12.32
3	76	2.50
4	30	0.99
≥ 5	12	0.40
Multiple birth	137	4.51
Attends nursery/Kindergarten	1,055	34.76
School graduation mother	***n***	**%**
Without a school-leaving certificate	23	0.76
Special school certificate	5	0.16
Secondary school	217	7.15
Intermediate Secondary School Certificate (MSA)	750	24.1
High school	531	17.50
University	1,507	49.65
MV	2	0.07
School graduation father	***n***	**%**
Without a school-leaving certificate	30	0.99
Special school certificate	8	0.26
Secondary school	390	12.85
Intermediate Secondary School Certificate (MSA)	671	22.11
High school	390	12.85
University	1,500	49.42
MV	46	1.52
Place of residence of child	***n***	**%**
Lives with mother and father	2,843	93.67
Lives with mother	150	4.94
Lives with father	1	0.03
Lives with mother and her new partner	27	0.89
Lives with father and his new partner	2	0.07
Does not live with biological parents (e.g., foster family, adopting parents)	12	0.40
Questionnaire answered by	***n***	**%**
Mother alone or with another person (e.g., father, new partner)	2,835	93,40
Father	194	6.39
Other (e.g., grandparents)	6	0.20

MV, missing value.

were reported not to be media-users (= parents indicated a daily use of 0 min for their child for all digital media devices indicated) (48.01%). The other 51.99% of children use electronic media for an average of 39.84 min ($SD = 34.30$, Min. = 1, Max. = 300) per day, of which about half is spend on screens (20.65 min; total screen time is defined as the sum of screen time spend with (Video-)Calling/Skype, Internet, movies/series, digital games, apps and digital books and newspaper). The following usage times occur among the media users: Most popularly used by children are music and audiobooks (19.19 min/day), followed by movies and series (16.88 min/day). Least used were the Internet (0.09 min/day) and digital picture books (0.33 min/day). As can be seen in Table 3, a children's average total media usage time per day increases with their age. There were no missing values for the media characteristics by child.

TABLE 2 Media characteristics by household and child.

Characteristic	Child			
Media devices available in the household	*n*	%	MV	
			n	%
Smartphone	2,836	93.44	0	0
TV	2,657	87.55	0	0
Laptop	2,552	84.09	0	0
Tablet	1866	61.48	0	0
Console	748	24.65	0	0
Alexa	436	14.37	0	0
Smartwatch	398	13.11	0	0
Smarttoy	70	2.31	0	0
Other	182	6.00	0	0

Media user or no media user	*n*	%	MV	
			n	%
No media user	1,457	48.01	0	0
Media user	1,578	51.99	0	0

Internet access child	*n*	%	MV	
			n	%
Free access to the internet	4	0.13	15	0.49
Internet child safety lock installed	634	20.89	23	0.76

Media use in nursery/ Kindergartens	*n*	%	MV	
			n	%
Total ($n = 1,055$)	64	6.07	7	0.66
Up to 1-year-olds ($n = 12$)	0	0	0	0
1-2-year-olds ($n = 251$)	8	3.19	0	0
2-3-year-olds ($n = 361$, MV = 2 = 0.55%)	18	4.96	2	0.55
3-4-year-olds ($n = 424$, MV = 5 = 1.17%)	38	8.86	5	0.66

MV, missing value; No media user means: parents indicated a daily use of 0 min for their child for all digital media devices indicated.

Only 0.13% of children have free access to the Internet and 20.89% of households have a child safety lock installed.

If we look at *media use in the nursery/kindergarten*, we see that on average 6.07% of those children who attend a nursery/kindergarten also consume media there. However, children under 1 year of age do not consume media in the nursery/kindergarten, the number of consumers then increases across the age groups and reaches 8.86% among the 3- to 4-year-olds.

3.1.2.1 Age differences

Among children who use digital media, total digital media usage time averages 28.51 min per day in the first year of life, 35.13 min per day in the second year of life, 43.71 min per day for 2- to 3-year-olds and 46.99 min per day for 3- to 4-year-olds. Due to the presence of heteroskedasticity [Levene's $F\ (3, 3{,}031) = 184.83$, $p \leq 0.001$], lack of a normal distribution and unequal group sizes, a Brown-Forsythe ANOVA was performed. This showed that there was a statistically significant difference in children's overall media use time between at least two age groups [Brown-Forsythe- $F\ (3, 3{,}031) = 360.69$, $p \leq 0.001$, $n = 3{,}035$]. The estimated $\omega^2 = 0.26$ indicates a large effect. Games-Howell post-hoc procedure showed that the mean value of children's media use differed significantly between all age groups.

The number of those who use *digital games* is increasing rapidly with age: while no digital games are used among the under-one-year-olds, the number of users doubles from the third to the fourth year of age (2- to 3-year-olds: 3.36%; 3- to 4-year-olds: 6.28%). While under-one-year-old media users watch *movies/series* an average of 4.39 min per day, the 1-2-year-olds increase it to 9.89 min, the 2-3-year-olds to 21.23 min and the 3-4-year-olds to 26.41 min.

A similar increase is seen in *total screen time* (up to 1 year old: 7.20 min; 1 to 2 years old: 14.38 min; 2 to 3 years old: 24.90 min; 3 to 4 years old: 30.14 min). Due to the presence of heteroskedasticity [Levene's $F\ (3, 3{,}031) = 338.50$, $p \leq 0.001$], lack of normal distribution and unequal group sizes, a Brown-Forsythe ANOVA was performed. This showed that there was a statistically significant difference in children's screen time between at least two age groups [Brown-Forsythe- $F\ (3, 3{,}031) = 438.02$, $p \leq 0.001$, $n = 3{,}035$]. The estimated $\omega^2 = 0.30$ suggests a large effect. Games-Howell post-hoc procedure showed that the mean value of children's screentime differed significantly between all age groups.

Time spent with music and audio books decreases with age (up to 1 year old: 21.31 min; 3 to 4 years old: 16.85 min). The time spent with ((Video-)Calling/Skype), internet and digital games hardly changes over the age range considered here. Children under the age of one do not use the internet. If we look at single children versus siblings, children with siblings are more often electronic media users (57.05%) than single children (45.65%). A chi-squared test confirmed that the percentage of electronic media users did differ by existence of siblings $\chi^2(1, 3{,}035) = 38.93$, $p \leq 0.001$. We see in particular that siblings spend more time watching films and series (19.59 min versus single children, 12.61 min).

3.1.2.2 Gender differences

In our sample, there are no *gender differences* between users of electronic media: 51.75% of male and 52.25% of female children are users. Looking at gender differences (media users only), boys ($M = 0.59$ min, $SD = 4.23$) played on average longer *games* than girls ($M = 0.31$ min, $SD = 2.33$). According to Mann Whitney U test, however, this was not a significant difference ($U(n$ boys $= 799$, n girls $= 779) = 308644.00$, $z = -0.96$, $p = 0.34$).

Girls ($M = 0.44$, $SD = 3.21$) read more digital picture *books* than boys ($M = 0.23$, $SD = 2.90$). However, according to Mann Whitney U test, this was not a significant difference ($U(n$ boys $= 799$, n girls $= 779) = 309810.00$, $z = -0.62$, $p = 0.53$).

Girls ($M = 21.18$, $SD = 23.49$) had a higher *screen time* than boys ($M = 20.13$, $SD = 23.06$). Again, according to Mann Whitney U test, this was not significant $U(n$ boys $= 799$, n girls $= 779) = 299664.00$, $z = -1.29$, $p = 0.20$. Girls ($M = 40.29$, $SD = 34.43$) also had higher average daily *media usage times* than boys ($M = 39.40$, $SD = 34.19$) but

TABLE 3 Frequency and percentage of children's media use and child average daily media usage time by age, gender, and siblings present or missing.

Child media use	Total	Up to 1 year old	1 to 2 years old	2 to 3 years old	3 to 4 years old	Male	Female	Single child	Has siblings
N	3,035	1,388	703	487	457	1,544	1,491	1,345	1,690
***n* %**	100	45.73	23.16	16.05	15.06	50.87	49.13	44.32	55.68
No media user *n*	1,457	1,134	271	41	11	745	712	731	726
No media user %	48.01	81.70	38.55	8.42	2.41	48.25	47.75	54.35	42.96
Media user *n*	1,578	254	432	446	446	799	779	614	964
Media user %	51.99	18.30	61.45	91.58	97.59	51.75	52.25	45.65	57.04
from here on, all data refer to media users only:									
Digital gaming user *n*	47	0	4	15	28	27	20	19	28
Digital gaming user %	2.98	0	0.93	3.36	6.28	3.38	2.57	3.09	2.90
No digital gaming user *n*	1,531	254	428	431	418	772	759	595	936
No digital gaming user %	97.02	100	99.07	96.64	93.72	96.62	97.43	96.91	97.10
Child (Video-) Calling/Skype time	1.79	2.25	2.62	1.43	1.10	1.69	1.90	2.42	1.39
Child internet time	0.09	0.00	0.01	0.20	0.10	0.10	0.08	0.07	0.10
Child movies/ series time	16.88	4.39	9.89	21.23	26.41	16.56	17.20	12.61	19.59
Child digital games time	0.45	0.00	0.06	0.63	0.90	0.59	0.31	0.58	0.37
Child digital picture books time	0.33	0.00	0.37	0.16	0.67	0.23	0.44	0.24	0.40
Child other media time	1.11	0.55	1.43	1.25	0.97	0.95	1.26	1.45	88
Child total screen time	**20.65**	**7.20**	**14.38**	**24.90**	**30.14**	**20.13**	**21.18**	**17.38**	**22.73**
Child music/ audiobook time	19.19	21.31	20.75	18.82	16.85	19.28	19.11	22.35	17.18
Child total media usage time	**39.84**	**28.51**	**35.13**	**43.71**	**46.99**	**39.40**	**40.29**	**39.73**	**39.91**

No media user means: parents indicated a daily use of 0 min for their child for all digital media devices indicated; Total screen time = screen time spend with (Video-) Calling/Skype + Internet + movies/series + digital games + apps + digital books and newspapers; Total media usage time = Total screen time + music/audiobook; All times are in minutes.

also, the difference was not significant according to Mann Whitney U test ($U(n$ boys = 799, n girls = 779) = 310476.00, $z = -0.81$, $p = 0.94$).

3.1.3 Media characteristics by parents

The vast majority of parents use digital media (mothers: 99.11%; to a slightly lesser extent fathers: 92.36%; see Table 5). The following usage times occur among the media users. Mothers spend on average 192.68 min a day using various media. Looking more closely at the mothers' usage time, on an average day 159.57 min are spent on screen media, 53.20 min on watching films and series and 47.51 min on the internet. Fathers spend a daily average of 268.92 min using media, 240.46 of those on screens. Leading among fathers were movies and series as well as the Internet, each with about 57 min per day.

TABLE 4 Frequency and percentage of children's use of electronic media in different contexts (overall and separated by the first 4 years of life) in parental judgment.

Contexts of use of electronic media in parental rating	Total (n = 1,578)		Up to 1 year old (n = 254)		1 to 2 years old (n = 432)		2 to 3 years old (n = 446)		3 to 4 years old (n = 446)	
	n = 1,072 (MV = 506)	67.93% (MV = 32.07%)	n = 111 (MV = 143)	43.70% (MV = 56.30%)	n = 278 (MV = 154)	64.35% (MV = 35.65%)	n = 327 (MV = 119)	73.32% (MV = 26.68%)	n = 356 (MV = 90)	79.82% (MV = 20.18%)
At mealtime	65	6.06	5	4.50	19	6.83	29	8.87	12	3.37
Before bedtime	304	28.36	30	27.03	65	23.38	96	29.36	113	31.74
To occupy/calm the child	403	37.59	58	52.25	119	42.81	112	34.25	114	32.02
During waiting times	205	19.12	11	9.91	48	17.27	71	21.71	75	21.07
When parents have no time (e.g., doing chores etc.)	480	44.78	18	16.22	100	35.97	153	46.79	209	58.71
With other children	160	14.93	17	15.32	65	23.38	45	13.76	33	9.27
Total	**1,617**	**150.84**	**139**	**125.23**	**416**	**149.64**	**506**	**154.74**	**556**	**156.18**

For media users only; Multiple answers are possible; MV, missing value.

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TABLE 5 Frequency and percentage of media use by mother and father and average daily media usage times.

Characteristic	Mother			Father		
Media user or no media user	*N*	%	MV	*n*	%	MV
No media user	22	0.72	5 (0.16%)	118	3.89	114 (3.76%)
Media user	3,008	99.11		2,803	92.36	

From here on, all data refer to media users only:										
Media usage time	*M*	*SD*	Min.	Max.	MV	*M*	*SD*	Min.	Max.	MV
(Video-) Calling/ Skype	14.09	26.95	0	480	0	22.21	52.44	0	510	0
Internet	47.51	45.65	0	480	0	57.29	59.14	0	720	0
Movies/series	53.20	48.62	0	480	0	56.83	48.42	0	360	0
Digital games	2.49	12.21	0	240	0	12.08	30.46	0	420	0
Apps	24.50	30.76	0	420	0	22.98	30.82	0	300	0
Digital books and newspaper	9.82	20.29	0	300	0	14.71	25.09	0	300	0
Other	7.96	49.68	0	510	2	54.36	138.25	0	720	0
Total screen time	**159.57**	**105.90**	**0**	**990**	**0**	**240.46**	**194.61**	**0**	**1,290**	**0**
Music/ audiobooks	33.11	61.00	0	960	0	28.47	57.21	0	960	0
Total media usage time	**192.68**	**132.21**	**3**	**1,080**	**0**	**268.92**	**212.18**	**7**	**1,500**	**0**

No media user means: parents indicated a daily use of 0 min for all digital media devices indicated; Total screen time = screen time spend with (Video-) Calling/Skype + Internet + movies/ series + digital games + apps + digital books and newspapers; Total media usage time = Total screen time + music/audiobook; All times are in minutes; MV, missing values.

TABLE 6 Descriptive statistics of S-CIUS values (parents) total and by child age, child gender, and siblings present or missing.

Items S-CIUS (parents)	Total	Up to 1 year old	1 to 2 years old	2 to 3 years old	3 to 4 years old	Male	Female	Single child	Has siblings
M	3.03	2.65	3.25	3.50	3.38	3.01	3.06	2.89	3.15
SD	2.78	2.59	2.90	2.89	2.91	2.77	2.81	2.76	2.80
Minimum	0	0	0	0	0	0	0	0	0
Maximum	16	14	16	13	13	16	14	16	15
Cut-off S-CIUS	≥ 7								
n ≥ cut-off	356	124	94	71	67	179	177	148	208
% ≥ cut-off	11.73	8.93	13.37	14.58	14.66	11.59	11.87	11.00	12.31

Looking at the S-CIUS scores (see Table 6), in total, 356 parents (11.73%) had a result above the cut-off 7, which implies Problematic Internet Use. Overall, the average total value was 3.03 (see Table 6).

3.1.4 Reciprocal relationship between familial factors and media usage

Parents of multiple children ($M = 3.15$, $SD = 2.80$) scored higher in S-CIUS than parents of only children ($M = 2.89$, $SD = 2.76$). A Mann Whitney U Test indicated that this difference was statistically significant ($U(n$ multiple children $= 1{,}690$, n single child $= 1{,}345) = 1069973.50$, $z = -2.80$, $p \leq 0.01$). The effect size according to Cohen (59) is Pearson $r = 0.05$ and is below a small effect ($r = 0.10$).

The S-CIUS score of parental media use also differed depending on the *age of the child*. In the first year of life, the parents' S-CIUS total score was 2.65 (8.93% above the Problematic Internet Use PIU cut-off), in the second year of life 3.25 (13.37% PIU), in the third year of life 3.05 (14.58% PIU) and in the fourth year of life 3.38 (14.66% PIU). An ANOVA with the 4-fold stepped factor age was calculated on the S-CIUS total values. Due to heteroskedasticity [Levene's F (3, 3,031) = 8.45 $p \leq 0.001$], lack of normal distribution and unequal group sizes a Brown-Forsythe-ANOVA was performed. This revealed that there was a statistically significant difference in terms of Problematic Internet Use (S-CIUS total score) between at least two groups [Brown-Forsythe-$F(3, 3{,}031) = 17.53$, $p \leq 0.001$, $n = 3{,}035$]. The estimated $\omega^2 = 0.02$ suggests a small effect. Games-Howell post-hoc procedure revealed that the mean S-CIUS total score differed significantly

TABLE 7 Multiple linear regression analysis results (n = 3,035) with "total media usage time of child" (averaged over media and no media users) as criterion.

Criterion: "total media usage time of child"					
Predictors:	*B*	*SE B*	*β*	*T*	*p*
Total media usage time of mother	0.03	0.01	0.11	5.79	0.00**
Total media usage time of father	−0.00	0.00	−0.01	−0.35	0.72
S-CIUS-total-score	0.60	0.18	0.05	3.43	0.00**
School graduation mother	−1.41	0.58	−0.05	−2.45	0.01*
School graduation father	−2.28	0.51	−0.09	−4.46	0.00**
Child gender	0.21	0.96	0.00	0.22	0.83
Child age	1.28	0.04	0.56	34.20	0.00**
Siblings	−2.64	1.00	−0.04	−2.65	<0.01*

$F(8,2,888) = 170.05$, $p \leq 0.001$, $R^2 = 0.32$, $R^2_{adjusted} = 0.32$. *B* represents unstandardized regression weights, *SE B* represents standard error for *B*. Beta indicates standard regression weights; *$p < 0.05$; **$p < 0.001$.

between parents of infants up to 1 year old and parents of all other age groups [compared to 1–2 year old infants $p \leq 0.001$, 95% C.I. = (−0.94;-0.27); compared to 2–3 year old infants $p \leq 0.001$, 95% C.I. = (−1.24;-0.47); compared to 3–4 year old infants $p \leq 0.001$, 95% C.I. = (−1.13;-0.34)]. Otherwise, there were no statistically significant differences between the older age groups (comparison of 1-2-year-olds with 2-3-year-olds $p = 0.45$; comparison of 1-2-year-olds with 3-4-year-olds $p = 0.88$; comparison of 2-3-year-olds with 3-4-year-olds $p = 0.92$). Further descriptive data concerning the S-CIUS are found in Table 6.

Parents were asked about the *contexts of electronic media use* using predefined categorie (see Table 4). In the total sample of media-using children, 44.78% of children were allowed to use electronic media when parents did not have time, 37.59% of children were occupied with electronic media to calm them down, 28.36% before going to sleep, 19.12% during waiting times, 14.3% with other children and 6.06% at mealtimes. Specifically in the first year of life, media are used to occupy and calm the child (52.25%) in contrast to the following 3 years of life (42.81, 34.25, 32.02%). Additionally, the reason 'lack of time' shows an increase with age (16.22% in the first, 35.97% in the second, 46.79% in the third and 58.71% in the fourth year of life).

3.2 Multiple contextual influences

A multiple regression analysis (method enter) was used to predict *total media usage time* of all children (media and no media users) from total media usage time of all mothers, total media usage time of all fathers, parental S-CIUS-Total-score, school graduation mother, school graduation father, child gender, child age and single child versus child with siblings (Table 7). The model explained a statistically significant amount of variance in total media usage time of child, $F(8,2,888) = 170.05$, $p < 0.001$, $R^2 = 0.32$, $R^2_{adjusted} = 0.32$. Significant predictors were: total media usage time of mother ($ß = 0.11$, $t = 5.78$, $p \leq 0.001$), S-CIUS-Total-score ($ß = 0.05$, $t = 3.43$, $p < 0.001$), school graduation mother ($ß = -0.05$, $t = -2.45$, $p = 0.01$), school graduation father ($ß = -0.09$, $t = -4.46$, $p < 0.001$), child age ($ß = 0.56$, $t = 34.20$, $p < 0.001$.) and siblings ($ß = -0.04$, $t = -2.65$, $p < 0.01$). Therefore, the final predictive model was: Total media usage time of child = 11.40 + 0.03 (total media usage time of mother) + 0.60 (S-CIUS-Total-score) −1.41 (school graduation mother) −2.28 (school graduation father) + 1.28 (child age) −2.64 (siblings). Increasing maternal total media usage time, Problematic Internet Use, lower school leaving certificate of mother, lower school leaving certificate of father, increasing age and being an only child lead to higher child media usage time. The R^2 for the overall model indicates a substantial goodness of fit according to Cohen (59), $f^2 = 0.47$ (large effect). Child's gender and total media usage time of father were no significant predictors of child's electronic media usage time.

4 Discussion

The present study examined the digital media use and media availability in the first 4 years of life of more than 3,000 children. Young children's media use was examined in relation to the media use of their parents, their parents' Problematic Internet Use, the educational attainment of their parents and family composition.

The hypotheses put forward at the beginning were partly confirmed, with mothers' media usage, level of education of mother and father and children's age being relevant predictors in the assumed capacities. There are no significant gender differences in the media use times of children at this early age. Siblings in this study are a factor that significantly diminishes young children's media usage rather than increase it. In the first 4 years of their children's lives, electronic screen media are used by parents comprehensively and depending on children's age in different contexts (eating, falling asleep) and with different functions (to occupy/calm the child). In addition, we observed that parents of siblings had a higher S-CIUS score than parents of only children and that there was an increase in S-CIUS scores between parents of children under 1 year and parents of children aged 1 to 3 years.

4.1 Media characteristics by child

According to the results of our study, more than half of the 0- to 4-year-old children spend approximately 40 min using *electronic media* per day. However, of these 40 min of daily electronic media use, the use of music/audiobook with over 19 min makes up the largest part (main share). Listening, singing and dancing are

highly-encouraged activities, which parents can offer to their children from an early age, either in person or through electronic media. Nevertheless, an average total screen time of 20.65 min per day remains for the first 4 years of life.

Ferjan Ramírez et al. (60) report 58 min of daily electronic media exposure in 6- to 24-month-old children and results of the miniKim-Studie (61) show comparable results to the present study, reporting that 2–3-year-olds spend 34 min watching TV. Additionally, 4% of 2–3-year-old use computer, console or online games at this early age. This is in line with results of the present study, reporting that about 3% of 2–3-year-olds and 6% of 3–4-year-olds use digital games. However, the results of our study reveal a deviation of the current practice from the recommendations of the American Academy of Pediatrics (AAP) (37, 62). Our study shows 18.30% media users in the first year of life and 61.45% media users in the second year (Table 3). If we look at the media usage times of only the media users, we find an average of 4.93 min daily for "child movies/series time" already in the first year of life and an average of 9.89 min daily in the second year of life. As well as an average daily total screen time of 7.20 min in the first year of life and 14.38 min in the second year of life. Even if we take into account that the total screen time in the first year of life includes an average of 2.25 min of (Video-)Calling/Skype daily and in the second year of life an average of 2.62 min of (Video-) Calling/Skype daily, these descriptive results deviate from the recommendations of the AAP. The AAP recommends completely avoiding the use of digital media (with the exception of video-chatting) for children younger than 18 months. If children between the ages of 18 and 24 months are to be introduced to digital media, it should always be with a caregiver and with quality educational digital media content (37).

Looking at *total screen time*, half of the 0- to 4-year-old children in the present study spend approximately 20 min in front of a screen per day. Trinh et al. (63) show an average screen time of 30 min for toddlers and 2 h for 3-year-olds. Kracht et al. (64) report 1 h of screen time per day for 3-month-olds, 1.1 h for 12-month-olds and 1.7 h for 2-year-olds. Tandon et al. (65) found much higher numbers, whereby weekday screen time for preschool children was 4 h per day, in line with the findings of Cheng et al. (66). Tandon et al. (65) points out that the usage times in the nursery/kindergarten and especially in home-based childcare should not be underestimated. As we can see in the present study, 6.07% of the children already use media in the nursery/kindergarten. Since we did not measure the time spent with media in the nursery/kindergarten, we cannot compare it with the results of the study by Tandon et al. (65). However, this shows that media time in the nursery/kindergarten cannot be neglected as it could be one of the reasons for the observed lower usage times in our sample and has the potential to become a significant additional source in the cumulative daily screen time of young children in the future.

By the end of the first year of life, approximately one fifth (18.3% of the children in our sample) are already media users. Durham et al. (67) find much higher frequencies with 45% of children already interacting with digital media in their first year of life. Kiliç et al. (68) report an average age of 12 months for the first use of mobile devices. In the present study, the frequency of media use increases sharply in the second (61.45%) and third (91.58%) years of life and reaches almost full coverage in the fourth year of life at 97.59%. There are considerable increases especially in the second year of life (by more than 40%) and in the third year of life (by about 30%). Significant course settings in media use seem to take place in the early childhood years.

With increasing age, 0- to 4-year-old children in this study are reported to use media for an increasing amount of time per day, confirming previous findings of age being a predictor of media usage time [e.g., (47, 69)]. Certain and Kahn (70) found that 83% of 0 to 11-month-olds spend less than an hour a day watching TV while 48% of 12- to 23-month-olds spend at least 1 h every day watching TV. Among the 24 to 35 months old, 16% were reported to watch 5 or more hours of TV every day, while 41% of this age group were reported to watch at least 3 or more hours daily. This finding is in line with Duch et al. (24) noting that older children (about 36 months old) have a higher screen time than younger children. As children grow older, they gain more autonomy and independence, possibly to use media by themselves as well as more fine and gross motor skills that facilitate specific and extensive media usage.

Comparisons between our data and existing studies (and between existing studies themselves) are limited by different methodological approaches (e.g., how media use is measured in the different studies or how representative the sample is).

Regarding the varying media characteristics reported in the literature, cultural differences in policy and the different policies on internet use in different countries play an important role (71, 72). In Germany, for example, internet use policies take on a crucial role, as the digitalization campaign by the German government lays the framework for a substantial increase in the use of digital media, especially in the context of schools (73).

Parents were asked in which *contexts* electronic media are used in the first 4 years of life. Results show that media are mainly used to occupy the child, especially when parents do not have time or want to calm the child down, but also before falling asleep, during waiting times, with other children and at mealtimes. This is supported by the findings of Kabali et al. (74) and consistent with findings by Vandewater et al. (9). The results of the present study contrast again with recommendations from the AAP (37), emphasizing that media should not be used to distract the child. In addition, screens are to be turned off at least 1 hour before bedtime (75). Furthermore, mealtimes and parent–child times should be media-free times. Ventura et al. (76) raise the question of whether maternal use of digital media during infant feeding has a negative impact and found that there was a negative association with some aspects of the quality of feeding interaction. In our study, during the first years of life, electronic media are used especially to occupy and calm the child. As children get older, media were used more often when parents do not have time. When it comes to media use during mealtime, we found an inverted U-shaped relationship. It seems that at the time of learning to eat independently (second and third year of life), electronic media are used particularly intensively.

In the present study, no significant *gender differences* were found with regard to screen and media use time. Consistent with previous research on older children [e.g., (53, 77)], this sample of younger children also indicates a tendency for boys to spend more time playing digital games. Girls, on the other hand, spent more time with digital picture books, which is in line with the finding of Jabbar & Warraich (78) reporting that girls are more frequent readers than boys. As girls get older, there is a higher preference for Social Media use in adolescence than in boys (77), and some studies also report more

Problematic Internet Use in girls than in boys (16). To summarize, on the one hand, there is a tendency and direction toward these gender differences known from studies of older children. On the other hand, these gender-specific findings in the present study are not statistically significant. Thus, one could conclude that gender differences are not yet so pronounced at this early age. However, there is a lack of research and comparable studies on infants and young children on this topic.

4.2 Family context factors

The aim of the present study was to find predictors for the media use of young children, looking more closely at family factors, as there is a lack of studies for infants and toddlers in this research area. In line with prior research identifying parental media usage as a strong predictor for children's digital media use [e.g., (41, 79, 80)], it was found that one of the major predictors in the sample of 0- to 4-year-old children was *maternal media usage*. Children spend more time watching television, playing video games and generally using screens, when their parents have a higher media consumption themselves [e.g., (42, 81)]. Woodard and Gridina (82) note that this applies especially for those parents who are heavier media users. If, for instance, a parent spends more than 2 h per weekday watching television, young children have been found to be at least 3.4 times more likely to also spend more than 2 h watching TV (83). Durham et al. (67) also point out that family TV time is a major predictor of infant screen time. In previous studies specifically mothers' screen time (e.g., watching TV) has been found to predict the time young children spend in front of screens or engaging in media (24). The positive association between maternal media use and children's media usage might be attributed to the fact that children learn their behavior by observing their caregivers' interaction with the world (41, 84), as described in Bandura's theory of social learning (85). In addition, parents' attitudes toward the effects of media use also play a major role here, as these affect and shape the way in which parents value media in their homes (84). Parents who perceive media use as less harmful to their children may also be more inclined to expose them to more media devices more often.

In our study, the extent of *paternal media usage* was not a significant predictor of the child's screen time. So far there has been little to no research finding comparable results for fathers when looked at outside of a parental dyad and their media usage. This relative lack of literature investigating the paternal influence on children's media usage might be caused by mothers spending more time caring for, interacting with and even just being in the presence of their child than fathers, whose time with their children is often mediated by the presence of the mother (86). This is especially true for the first 2 years of life, when the mother plays a very significant role in parent–child interaction and - at least in the traditional model still predominant in Germany - fathers are less involved. The mother's media consumption seems to be a significant influencing factor for the child's media use in the first years of life, while the father's is not. This implies that mothers are an important target group for early prevention. Kiliç et al. (68) for example showed that there is a great lack of knowledge about the effect of mobile devices: 95% of the parents who participated in their study reported that they have not been informed about the effect of mobile devices on their children by a doctor. Universal prevention programs for mothers during pregnancy and the newborn period could be implemented to share information about possible adverse effects of maternal media use. At the same time, for mothers as the main caregivers of very young children in most Western societies, there are also opportunities in the use of screens, namely to counteract the dangers of social exclusion (87) through the use of social networks. However, it is certainly favorable if this does not happen during mother–child interaction.

In addition to the mother's screen time, the *parents' Problematic Internet Use (PIU)* also plays a significant role in its effects on the child's media use time, which is in line with the findings of Hefner et al. (88). The positive prediction power of parents' PIU possibly indicates that parents who use the internet problematically also fail to see the dangerous consequences of digital media use for their young children, which is why their children's media usage time might not be a (big) concern for them.

Looking at the difference in S-CIUS scores between *parents with more than one child and parents with only children*, in the present study we found that parents with more than one child have higher S-CIUS scores, indicating more PIU. To the best of our knowledge there are no studies on this topic in the current literature. Possible explanations could be that parents of multiple children have more time to use digital media because the children are engaged with each other and require less attention from parents. It could also be that the use of digital media serves as an emotion regulation strategy (89, 90) or as a coping mechanism (89, 91) due to for example increased stress caused by multiple children [e.g., (92)]. Another explanation might be that parents of several children have less opportunities for activities outside the home.

In addition, the present study found, that the *S-CIUS score of parents of 1- to 4-year-olds* increases sharply compared to the score of parents of under one-year olds. PIU of parents was significantly lower in the first year of life than in the 2 to 4 years of life of their children, increasing sharply in the second year of life. It can be speculated that there is less time and/or need to develop a PIU in the first year of life. Further studies are warranted to confirm this finding and to investigate possible mechanisms and explanations.

The present study shows that maternal and paternal *education level* significantly predicts children's media usage time. Children of parents with higher education levels spend less time using media than children of non-academic parents, which is in line with findings of Anand and Krosnick (47) and Kiliç et al. (68). More educated parents reported less leisure media usage (81) and higher family income was negatively associated with parental media use as well (93). This is in line with the findings of Rey-López et al. (94), noting that not only parental education but also occupation influences time spent watching television. Looking specifically at maternal education, almost double the amount of mothers who had not graduated high school than of mothers who were college graduates reported that their 2 year olds watched at least 3 h of television a day (70). A woman who had not graduated from high school was almost 4 times as likely as a woman who had graduated from college to report that her 0- to 11-month-old watched at least 1 h of television per day. Overall, families with young children who have a comparatively high or even very high media intake are significantly lower educated and have a lower annual income than families who report a moderate or low usage of media. This could stem from parents with a higher level of education being more knowledgeable and educated about adverse effects of early life media

usage and also being more likely to seek advice from doctors (95). Therefore, parents with a higher socioeconomic status might establish more and stricter rules regulating their children's media and screen time and might develop these rules in a participatory joint conversation with their children (96), which could lead to a sustainable pursuit of these rules. Sebre et al. (97) highlight the importance of rules regarding social media use noting that reported rules for internet use by children were linked to lower ratings of problematic use of the internet. Additionally, parents with a higher socioeconomic status appear to be providing a reduced availability of media devices to their children compared to lower educated parents as Nikken and Schols already found in 2015 (42). Kabali et al. (74) report that young children in an urban, low-income, minority community had almost universal exposure to mobile devices, and most had their own device by the age 4. Furthermore Tandon et al. (44) note that children from lower income households are provided with a greater access to media in their bedroom and at the same time have lower access to other play equipment which promote physical activities, such as for example bikes.

In contrast Mollborn et al. (98) found that higher-socioeconomic children spend a similar amount of time with digital media devices to other groups and at the same time do not have more rules, than children from socio-economically disadvantaged families, regarding the use of digital media. This contradicts previous findings. One possible explanation the authors refer to is a theroretical perspective stating that more "advantaged" parents tend to follow an "individualistic parenting approach" (99).

When looking at specific types of media usage, Anand and Krosnick (47) found that children with fathers who either had some college education or who were college graduates were shown to spend more time using computers than children whose fathers had no high school education. This pattern is also evident in relation to playing video games or watching DVDs/videos. This could raise the question if and how various types of media usage differ and how they might be predicted or influenced by varying factors to varying degrees.

The results of our study, like those of many others state that low parental education and a low socioeconomic status are associated with children spending more time watching TV [e.g., (70, 100)]. Mollborn et al. (98) confirm this finding and note that children brought up by a college-educated primary caregiver spend less time watching TV, but more time with non-TV technology. In conclusion, one could assume that a poorer level of education could be passed on transgenerationally to the children of these families through more intensive exposure to screen media.

The present study found that *siblings* turned out to be a protective factor regarding media usage time, having siblings decreased the daily average time spend on media. As for why this is the case, it can be speculated that children who are and have siblings spend part of their leisure time with their sibling(s) instead of using media. This is in line with the findings of Bagley et al. (51) and Davies and Gentile (101). However, there are also other studies that show the opposite: Hardy et al. (102) for example found that the presence of siblings increased the time spend watching TV. The presence of other people, including siblings, during screen time is a contextual feature and thus a situational influence that could affect young children's media-related behavior (103). As children often spend a lot of time with their siblings, even more so than with their parents [McHale and Crouter (104) as quoted in Davies and Gentile (101)] it is highly relevant to conduct further research on topics such as the potential function of the sibling as a role model, the effects of age differences between siblings, their impact on media use, and the effects of sharing digital devices (101).

5 Strengths and limitations

The inclusion of a relatively large data set of infants and toddlers and their parents offered the possibility to relate the children's media use to that of their parents. In addition, other family factors such as the parents' level of education and the number of siblings were included. The recording of media time for the child as well as for the mother and father was not done as a total value, but very differentiated according to individual categories [e.g., (Video-)Calling/Skype, internet, movies, games, picture books, audiobook]. These are all strengths of this study and extend the current literature.

As for limitations, the present study is a cross-sectional study identifying correlations, but ultimately no causal relationships. Nevertheless, we consider it more likely that family factors such as parents' media use time, income or parental PIU score have an impact on the very young child's media use time rather than vice versa. However, it seems that eventually there are reciprocal relationships, thus the parental PIU is lower in the first year of the child's life than in the 2nd-4th year of the child's life.

Critically it was only recorded whether children watch television and whether there is a television in the house, but not how much television is watched (only generally "watch movies/series"). Therefore, it is problematic to distinguish whether the time spent watching films and series is spent on the television or perhaps on the computer, smartphone or tablet, which makes it difficult to compare the present results with other studies. Similarly, the item "playing digital games" did not distinguish between educational and non-educational games. However, at present there is little research distinguishing „high-quality" (37) educational games versus non-educational games.

With 49% of both parents having a university degree and over 90% of the children living with their mother and father, the question arises as to the representativeness of the sample studied (even though it is very large). It could be assumed that more educationally distant family systems would tend to result in higher media use times.

The questionnaires used in the present study were self-report questionnaire which could lead to response biases such as under- and over-statements, as well as socially desirable answers. Furthermore, only the parents filled in the questionnaire, so there are no other data sources. Parents' perceptions of their children's time spent using media may be biased, inaccurate and underestimated, especially for parents with high S-CIUS scores as they may have no insight into their own or their children's problematic behavior. Additionally, PIU was assessed only using 5 out of the 14 original items with the short version of the CIUS (S-CIUS) (56). Another issue is that the socio-economic status of the parents was only measured through educational attainment and not through further factors such as income, profession, or resources in the household.

6 Conclusion and outlook

In conclusion, this study yields indications for a possible problematic media consumption in early childhood in respect of the

high percentage of media use in early childhood (51.99%), the average total daily screen time (20.65 min) and the context (e.g., pacifying in absence of parental resources even before bedtime) of media use. In light of the results of the present study, it is important to keep the plentiful adverse effects of media consumption in very early childhood in mind, such as negative repercussions on social, emotional, cognitive, verbal and motor skill development as well as nutrition and sleep (17–22, 81, 104–106). Excessive use of digital media can also lead to the neglect and abandonment of activities like physical exercise (107). However, some studies fail to find a negative effect (108, 109). As for the possible positive effects of using digital media at a young age, there is currently little evidence (110, 111). The AAP recommends parental interaction with the child during media use in order to provide support and guidance and to prevent excessive digital media use (37).

Because of the high educational level of the study population and the fact, that low education is correlated with high media consumption this study is very likely to underestimate the situation in the normal population. Preventive efforts to reduce the use of digital media especially among infants and toddlers seem mandatory, as early life is potentially highly relevant for further media socialization, as well as the family. There is a risk that kindergartens are playing an increasingly important part in digital socialization, however, they could also be targeted as a starting point for prevention. From the data of our study, first conclusions for prevention strategies may be drawn. The role model function of parents has to play a central role, access by the less educated population has to be assured and communication programs through pediatric practitioners should be established. Overall, this seems to be of particular relevance in order to compensate for the plethora of adversities encountered by socially disadvantaged children. Recognizing that media are a potential mediator for the transgenerational transmission of educational attainment (and ultimately Socioeconomic status SES) offers further starting points for specifically tailored indicated prevention programs.

Future research should focus on longitudinal studies to examine possible reciprocal relationships between parental PIU and the age of the child, as well as consider age of the child as a moderating factor in the relationship between parental PIU and child media use. In addition, a broader range of participants with a more diverse parental educational background as well as different living circumstances (e.g., lives with the mother and her new partner, lives with father) is needed. Regarding the contradictory findings on siblings, more research is needed on topics such as the influence of siblings' age, the impact of sharing digital devices and also possible gender effects. In general, there is a need for more studies on infants and toddlers on the topic of digital media.

The qualitative criteria mentioned for PIU or IA or GD of adults are not transferable to toddlers and infants, for whom primarily quantitative time criteria are recorded. However, pure screen time, which was used as a quantitative measure in this study and in many other studies, does not appear to be sufficient. Future research should develop the qualitative structure and criteria of dysfunctional and disturbed media consumption in infants and children beyond the time of use.

A next step would then be to include corresponding age-appropriate criteria in the DC:0–5 (112). [The *Diagnostic Classification of Mental Health and Developmental Disorders of Infancy and Early Childhood* (DC:0–5) is a multiaxial classification system for mental disorders in early childhood providing a framework for standardizing clinical practice and research (113)].

Qualitative criteria for screen use such as educationally valuable applications, age appropriateness of the programs and level of quality of the programs need to be considered and researched more extensively. Only then will we be able to better understand what really happens during children's screen time and how screens ultimately affect children's development and parent–child interactions.

Data availability statement

The datasets presented in this article are not readily available because the data that support the findings of this study are available from VM (Munich) upon reasonable request. Requests to access the datasets should be directed to VM, Volker.Mall@kbo.de.

Ethics statement

The studies involving humans were approved by Ethics committee of the Technical University of Munich (No. 278/18S-AS; date 16.08.2018). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

FP: Conceptualization, Data curation, Methodology, Supervision, Visualization, Writing – original draft, Writing – review & editing. JJ: Data curation, Formal analysis, Methodology, Software, Visualization, Writing – original draft. AF: Data curation, Investigation, Project administration, Resources, Validation, Writing – review & editing. TF: Data curation, Investigation, Project administration, Resources, Writing – review & editing. EM: Supervision, Writing – review & editing. VM: Conceptualization, Investigation, Methodology, Project administration, Supervision, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Parental use of routines, setting limits, and child screen use during COVID-19: findings from a large Canadian cohort study

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Background: An increase in child screen time has been observed throughout the COVID-19 pandemic. Home environment and parenting practices have been associated with child screen time. The purpose of this study was to examine associations between parental use of routines, limit setting, and child screen time during the (COVID-19) pandemic to inform harm-reducing strategies to limit the potential harms ensued by excessive screen use.

Methods: A cohort study was conducted in 700 healthy children (3,628 observations) aged 0–11 years though the TARGet Kids! COVID-19 Study of Children and Families in Toronto, Canada from May 2020-May 2021. The independent variables assessed were parent-reported use of routines and setting limits. Outcomes were parent-reported child daily screen time in minutes and whether the Canadian 24-Hour screen time guideline was met, defined as 0 for <1 years, 60 or less for 1–5 years, and 120 or less for >5 years. Linear and logistic mixed-effects models were fitted using repeated measures of independent variables and outcomes with *a priori* stratification by developmental stages (<3, 3–4.99, ≥5 years).

Results: A total of 700 children with 3,628 observations were included in this study [mean age = 5.5 (SD = 2.7, max = 11.9) years, female = 47.6%]. Mean change in child screen time before vs. during the pandemic was +51.1 min/day and level of parental use of routines and setting limits remained stable. Lower use of routines was associated with higher child screen time ($\beta = 4.0$ min; 95% CI: 0.9, 7.1; $p = 0.01$) in ages ≥5 years and lower odds of meeting the screen time guideline in ages <3 years and ≥5 years (OR = 0.59; 95% CI: 0.38, 0.88; $p = 0.01$; OR = 0.76; 95% CI: 0.67, 0.87; $p < 0.01$). Lower use of limit setting was associated with higher child screen time and lower odds of meeting the screen time guideline in ages ≥5 years ($\beta = 3.8$ min; 95% CI: 0.69, 6.48; $p < 0.01$; OR = 0.86; 95% CI: 0.78, 0.94; $p < 0.01$).

Conclusions: Lower parental use of routines and limits during the COVID-19 pandemic were associated with higher screen time and lower odds of meeting the screen time guideline among school-age children. Results may help inform strategies to promote healthy screen use in this age group.

KEYWORDS

child screen time, COVID-19, limit setting, routines, Canadian 24-hour Movement Guidelines

Background

Public health prevention measures have been implemented to combat the transmission of coronavirus disease (COVID-19) (1). During this period, substantial increases in child and adolescent screen time have been observed (2–4). While prosocial and educational content and parental engagement during child screen use can be beneficial, excessive use of all forms of digital media are associated with developmental and health concerns. The American Academy of Pediatrics has therefore suggested that guidance surrounding screen use include resources and realistic strategies that help parents monitor and limit screen time (5). The Canadian Society for Exercise Physiology has also established the Canadian 24-hour Movement Guidelines, which describes recommended amounts of sleep, screen time, and physical activity by age group (6). Meeting these guidelines have been associated with various positive health outcomes, prior to and during the COVID-19 pandemic (3, 7, 8).

Greater recreational screen time has been associated with various negative physical, social, and mental health indicators among school-age children and youth (9–11), both prior and during the COVID-19 pandemic, such as obesity, cardiometabolic factors, emotional problems, and prosocial behaviours. These negative associations also extend to children less than 5 years of age, where poorer sleep outcomes and psychosocial health and increased adiposity, motor or cognitive developmental delay have been observed (12, 13).

An increase in screen time was reported among Canadian children and youth (5–17 years) prior to during the COVID-19 pandemic (3, 14). Similarly, studies in South America, Europe, and North America also reported considerable increase in screen time among children 3–13 years (4).

Parents' behaviors may influence child screen time, and this association has been explained by two theoretical models. One model (15) emphasizes learning through observation, asserting that children develop screen use behaviours through watching their parents and siblings. The second model (16) posits that parents' attitudes and practices creates a microsystem that shapes that of the child. Implementation of routines and limits may lead to establishment of a home environment that discourages unhealthy behaviours in general, which can thereby impact a child's development and relationship with screen use in the broader ecological system.

Various household factors and parental characteristics and practices have been associated with child screen time. For instance, lack of screen-related home rules was associated with exceeding recommended screen time limits in a study of children ages 6–11 years (17). Similar findings were observed among younger children (0–7 years) (18). Meanwhile, a study ($n = 746$; 0–5 years) found parental perception of barriers to limiting child screen time, such as concerns about neighbourhood safety for outdoor play and the demands of busy work days or having multiple children, were associated with higher child screen time (19).

During the COVID-19 pandemic, a cross-sectional study of children ($n = 1{,}155$) 6–13 years found that a lack of rules regarding screen time was a significant predictor of higher child screen time (20). High levels of parental stress during the pandemic have also been associated with greater child screen time in a Canadian study of children 6–12 years (21). Furthermore, cross-sectional US studies during (22) and prior (23) to the pandemic found associations between higher chaotic household environments and higher child screen time. Higher child screen times were also reported when parents considered screen routines as less or un-important (22).

To our knowledge, there have been no published studies exploring the longitudinal association between routines and limit setting and screen time in children over multiple time points during the COVID-19 pandemic. Given that a paradigm shift towards a more virtual environment is likely to persist beyond the pandemic, this study's findings may help to inform harm-reducing interventions and parenting strategies of screen limits and parental use of routines to limit the potential harms ensued by excessive screen use (10, 24–27).

The primary objective of this study was to examine the longitudinal association between parental use of routines and setting limits with child screen time from May 2020 to May 2021 during the COVID-19 pandemic. The secondary objectives were to examine the association between parental use of routines and setting limits with meeting the Canadian 24-Hour screen time guideline and to describe any change in parental use of routines and setting limits over the study period. We hypothesized that higher parental use of routines and setting limits would be associated with lower screen time and likelihood of meeting the screen time guidelines in children among all age groups included in the study.

Methods

Study design and participants

A cohort study using parent-reported repeated measures of independent variables and outcome was conducted in healthy children (0–11 years) through The Applied Research Group for Kids (TARGet Kids!) COVID-19 Study of Children and Families in Toronto, Canada between May 2020 and May 2021. TARGet

Kids! is a large practice-based primary care research network in Canada, enrolling healthy children ages 0–5 years from primary health care settings and following them into adolescence (28). At each scheduled well-child visit, parents of participating children are invited to complete an age-specific questionnaire adapted from the Canadian Community Health Survey (CCHS), which includes questions on health and lifestyle factors and child health behaviours such as screen time and physical activity (29). The questionnaires also included socio-demographic information (e.g., family income, employment status, and ethnicity). The TARGet Kids! COVID-19 Study of Children and Families, which launched in April 2020, is nested within the larger TARGet Kids! Cohort. It aims to characterize the COVID-19 pandemic's impact on the children and parents living within the Greater Toronto Area in Canada to inform development of preventative initiatives against COVID-19. Since April 2020, parents participating in the TARGet Kids! longitudinal cohort were invited to complete repeated questionnaires either over the telephone or online via REDCap (30). The questionnaires' contents included physical and mental health and health behaviours of children and parents (e.g., sleep, screen time), parenting practices (e.g., limit setting and routine setting for children), adherence to public health measures, and school and childcare attendance during the COVID-19 pandemic. Informed Verbal consent was provided by all families participating in TARGet Kids!.

Independent variables

The independent variables of this study were parent-reported general use of routines and limits provided to children, as captured by the bi-weekly-administered question scales, respectively: *throughout the day, I provide my child with a 1 (a clear and orderly routine) to 7 (unstructured free time); I am the kind of parent that 1 (sets limits on what my child is allowed to do) to 7 (lets my child do whatever he or she wants).*

Outcomes

The primary outcome variable was parent-reported daily child screen time during the COVID-19 pandemic, captured in the bi-weekly questionnaire. Child screen time was defined as the sum of time spent while: (1) watching TV or digital media (i.e., Netflix, YouTube, web surfing); (2) using social media (i.e., Instagram, Snapchat, Twitter, TikTok); and, (3) playing video games. Screen time for videochatting/face-to-face communication, e-learning or online schoolwork, and watching or reading the news was excluded as these are pro-social activities which may have a positive impact on children during the COVID-19 pandemic. Observations were removed if one of the sub-variables used to compute the overall screen time variable was equal to or exceeded 10 h/day, or if the total screen time was greater than or equal to 12 h/day (31). The secondary outcome variable of meeting vs. not meeting the Canadian 24-Hour screen time guideline (6) was derived from the primary outcome variable, where meeting the guideline was defined as 0 min for <1 years, 60 min or less for 1–5 years, and 120 min or less for >5 years.

Covariates

Potential confounders identified *a priori* included child age (6), child sex (32–34), maternal ethnicity (32, 35–39), self-reported family income (32, 35–39), unemployment due to the COVID-19 pandemic (32, 35–39), number of siblings (40, 41), number of screen devices in the home (40, 42, 43), parental screen time during the COVID-19 pandemic (40, 44), child pre-COVID-19 screen time (45), and stringent lockdown measures in Ontario.

Parental screen time during the COVID-19 pandemic was obtained from the bi-weekly questionnaire. Implausible parental screen time values (exceeding 24 h/day) were removed and replaced using multiple imputation. This method is based on Fully Conditional Specification, where each variable that is missing data is imputed by a separate model (46). Ever having been unemployed due to the COVID-19 pandemic during this study period was determined from the following question administered on the bi-weekly questionnaire: *Have you been unemployed as a result of the COVID-19 pandemic? (Yes/No).* Stringent lockdown measures were defined as periods when preventative measures were most strict in Ontario and included stay-at-home orders and widespread closures. These periods during the study were May 20, 2020 to Sept 7, 2020 and November 23, 2020 to May 18, 2021. Child age was calculated from date of birth collected at the first administered TARGet Kids! COVID-19 Study of Children and Families questionnaire and the date of questionnaire completion. Child sex, maternal ethnicity, number of siblings, number of screen devices in the home, family income, and child pre-COVID-19 screen time were obtained from the most recently parent-completed questionnaire prior to the COVID-19 pandemic, which ranged from February 2012 to February 2020.

Parenting practices regarding screen time vary by age, with less control typically observed with older children (47–49). Furthermore, the influence of screen time on children also varies by age due to differing developmental abilities and stages (50). Therefore, the current study identified age as a potential effect modifier with strata being defined as <3 years (infants and toddlers), 3–4.99 years (preschoolers), and ≥5 years (school-age children) *a priori* based on the child developmental age groups (51) to allow for better understanding of parental practices and their relationship with child screen time in the context of different stages of development.

Statistical analysis

Linear and logistic mixed-effects models were fitted using repeated measures of independent variables (parental use of routines and parental use of setting limits) and outcomes (child screen time and meeting the Canadian 24-Hour screen time guidelines). To account for the study's inclusion of some children from the same family, random intercepts for family and subject

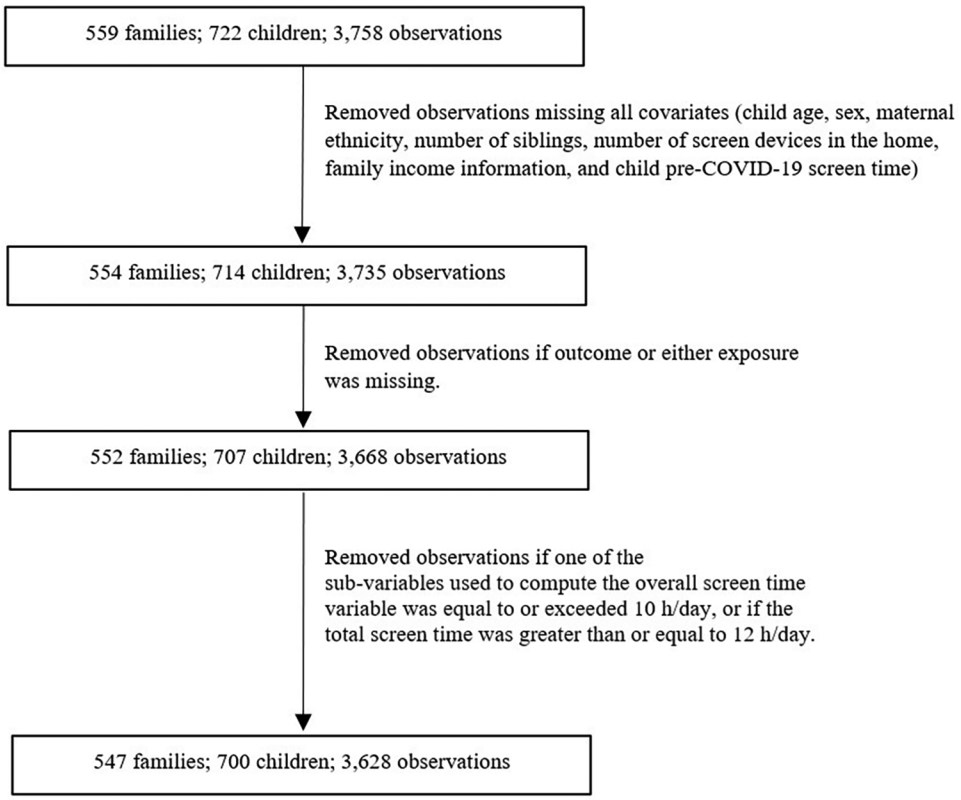

FIGURE 1
Sample size flow chart.

within family were included. Three models were fitted: (1) unadjusted; (2) adjusted for all covariates but excluding child pre-COVID-19 screen time; and, (3) adjusted for all covariates including child pre-COVID-19 screen time.

Missingness for each covariate was below 15%. Multiple imputation using 15 imputed datasets was performed using the *mice* package in R to account for bias related to missing data (46). Bootstrapping methods with 500 resamples per model were also performed using the *boot* package in R due to heteroscedasticity and non-normality of the model residuals, corresponding non-parametric confidence intervals and empirical *p*-value estimates are reported (52, 53). Statistical significance was set at $p < 0.05$ and all *p*-values were two-tailed. All analyses were conducted using R 4.0.2 (54).

Ethics approval

This study was approved by the Research Ethics Boards at The Hospital for Sick Children and Unity Health Toronto (TARGet Kids! Cohort Study #10000-12436 and #17-335).

Results

A total of 700 children with 3,628 observations were included in this study (Figure 1). Descriptive characteristics of the sample are presented in Table 1. Mean age of the children was 5.5 years (SD = 2.7 years), 47.6% of the children were female and 69.4% had mothers who reported European ethnicity.

Of the 700 children, 153 (22%) had 1 observation, 101 (14%) had 2 observations, and 446 (64%) had more than 2 observations. The mean number of observations per child was 5 observations. The mean follow-up duration for children with more than 1 observation was 48 days. The mean levels of parental use of routines and setting limits was 3.8 and 3.3 on a 7-point scale, respectively, with higher levels representing less use of routines and setting limits. Overall, the mean change in child screen time, from before to during the pandemic was 51.1 (95% CI: 47.8, 54.9) additional minutes per day. Larger increases were observed among older age groups in a dose-response manner. Mean child screen time during the study period was 126.0 min per day. 52.08% of children <3 years, 25.60% of children 3–4.99 years, and 32.89% of children >5 years met the Canadian 24-Hour screen time guideline on initial and all follow-up questionnaires. The mean level of parental use of routines ($m < 0.01$; $p = 0.10$) and setting limits ($m < 0.01$; $p = 0.42$) remained stable over the study period (Figure 2).

Table 2 presents the associations between parental use of routines, limits, and child screen time, stratified by child age groups. In the ≥5 years age group, for every additional level increase on the Likert scale towards lower parental use of routines there was 5.2 additional minutes of daily child screen time (95% CI: 2.25, 8.73; $p < 0.01$) in the fully adjusted model. In the 3–4.99

TABLE 1 Descriptive characteristics of the sample [$N = 700$ (3,628 observations; 547 families)].

Characteristics	Missingness *N* (%)	*N* (%) or mean (*SD*)	
Child age (years)[b]	0 (0.0%)	5.5 (2.7)	
Child sex[a]	0 (0.0%)	Female	333 (47.6)
		Male	367 (52.4)
Maternal ethnicity[a]	102 (14.6%)	European	414 (69.2)
		East Asian	51 (8.5)
		South/ Southeast Asian	56 (9.4)
		African	15 (2.5)
		Mixed	38 (6.4)
		Other[f]	24 (4.0)
Self-reported household income[a]	59 (8.4%)	$0 to $39,999	20 (3.1)
		$40,000 to $79,999	76 (11.9)
		$80,000 to $149,999	193 (30.1)
		$150,000+	352 (54.9)
Ever unemployed during COVID-19 (parent completing questionnaire)[c]	27 (3.9%)	Yes	44 (6.5)
		No	629 (93.5)
# of siblings[a]	43 (6.1%)	0	215 (32.7)
		1	341 (51.9)
		2	88 (13.4)
		3	13 (2.0)
# of screen devices at home[a]	0 (0.0%)	7.5 (3.6)	
Level of parental use of routines[c,d]	0 (0.0)	3.8 (1.5)	
Level of parental use of setting limits[c,e]	0 (0%)	3.3 (1.5)	
Parental screen time during COVID-19 (hours)[c]	0 (0.0%)	8.4 (4.2)	
Participants meeting screen time guideline[g]	0 (0.0%)	245 (35.0)	
Observations during most stringent lockdown periods[h]	0 (0.0%)	2,965 (81.7)	

[a]Last measure before COVID-19 (varying between February 7, 2012 and February 13, 2020).
[b]COVID-19 baseline questionnaire.
[c]Repeated measures collected during COVID-19 (May 20, 2020–May 18, 2021).
[d]Question scale: throughout the day, I provide my child with 1 (a clear and orderly routine) to 7 (unstructured free time).
[e]Question scale: I am the kind of parent that 1 (sets limits on what my child is allowed to do) to 7 (lets my child do whatever he or she wants).
[f]Other: Arab, Latin American, or Indigenous.
[g]Canadian 24-Hour screen time guideline: 0 min for <1 years, 60 min or less for 1–5 years, and 120 min or less for >5 years.
[h]May 20, 2020 to September 7, 2020 and/or November 23, 2020 to May 18, 2021.

years (95% CI: −2.15, 6.28; $p = 0.36$) and <3 years (95% CI: −2.04, 10.39; $p = 0.16$) age groups, there was insufficient evidence of an association between parental use of routines and child screen time. In the ≥5 years age group, for every additional level increase on the Likert scale towards lower parental use of limits, there was 3.3 additional minutes of daily child screen time (95% CI: 0.52, 5.90; $p = 0.02$) in the fully adjusted model. In the 3–4.99 years (95% CI: −3.98, 4.82; $p = 0.99$) and <3 years (95% CI: −3.56, 8.86; $p = 0.39$) age groups, there was insufficient evidence of an association between parental use of setting limits and child screen time.

Table 3 presents the associations between parental use of routines, setting limits, and meeting the Canadian 24-Hour screen time guideline. In the fully adjusted model, among children <3 years and ≥5 years, for every additional level increase on the Likert scale towards lower parental use routines, the odds of meeting the screen time guideline was lower in children <3 years and ≥5 years (OR = 0.59; 95% CI: 0.38, 0.88; $p = 0.01$ in children <3 years; OR = 0.76; 95% CI: 0.67, 0.87; $p < 0.01$ in children ≥5 years). There was insufficient evidence of an association among children 3–4.99 years (OR = 0.96; 95% CI: 0.77, 0.1.23; $p = 0.75$). The odds of meeting the screen time guideline was only lower in children ≥5 years for every additional level increase on the Likert scale towards lower parental use of limits (OR = 0.86; 95% CI: 0.78, 0.94; $p < 0.01$). There was insufficient evidence of an association among children <3 years and 3–4.99 years (OR = 0.65; 95% CI: 0.39, 1.01; $p = 0.07$). and 3–4.99 years (OR = 1.10; CI: 0.89, 1.35; $p = 0.38$).

Discussion

In this longitudinal study of a community sample of Canadian children under 12 years of age, we examined the relationships between parental use of routines and setting limits with child screen time during the COVID-19 pandemic from May 2020 to May 2021. Mean child screen time during the pandemic increased compared to pre-pandemic for all age groups (<3, 3–4.99, ≥5 years) and larger increases were observed with each older age group. Our results provided evidence that lower parental use of routines and setting limits was associated with higher child screen time and lower odds of meeting the Canadian 24-Hour screen time guideline among the ≥5 years age group before and after adjusting for pre-COVID-19 child screen time in addition to other covariates. The magnitudes of screen time increase for each single additional level increase on the Likert scale towards lower parental use of routines and limits, though small, demonstrate a more clinically relevant increase when comparing the degree of routine and limit implementation at opposite ends of the spectrum.

Restrictions implemented to curb the spread of COVID-19 have resulted in increased demands of homeschooling or supervising children while adapting to work-related changes. This has put considerable strain on parents, as reflected by reports of poorer mental health by parents (55, 56). As such, ensuring that children meet recommended screen time guidelines (6) may be especially challenging. Specifically in Ontario, stay-at-home measures and some of the longest school and daycare closures implemented throughout periods in 2020–2021 among the Canadian provinces must be considered as factors contributing to increases in child screen time. Beyond the pandemic and related restrictions, it is important to also acknowledge that many families will continue to face barriers that make meeting the screen time guideline for children very difficult, such as lack of affordable alternate activities and parental fatigue and stress (57). The findings of our study can thus contribute to informing potential strategies that help parents implement methods that encourage healthy screen time when possible as there is likely to be a fine balance between obtaining the benefits of screen use such as for prosocial activities and learning (58), and its

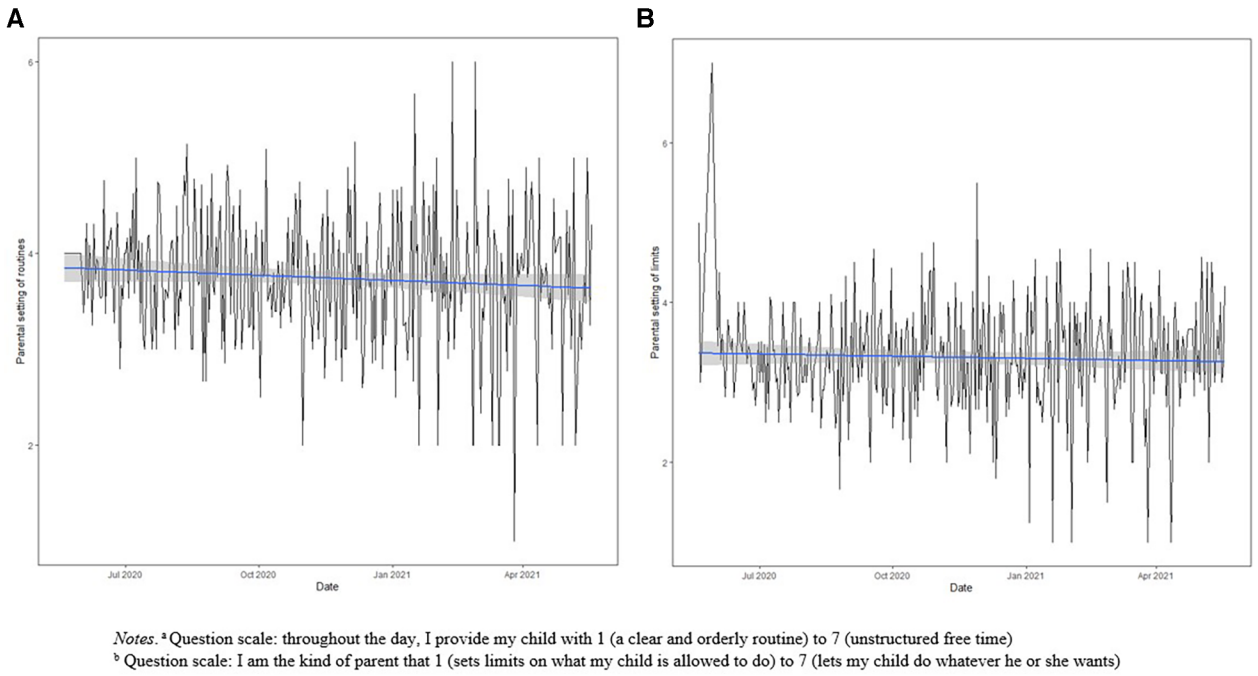

FIGURE 2
Mean parental use of (A) routines and (B) limits from May 20, 2020 to May 18, 2021 with linear model and 95% confidence level interval for predictions. (A) Question scale: throughout the day, I provide my child with 1 (a clear and orderly routine) to 7 (unstructured free time). (B) Question scale: I am the kind of parent that 1 (sets limits on what my child is allowed to do) to 7 (lets my child do whatever they want).

detrimental effects such as sedentary behaviour and mental health symptoms, particularly during the COVID-19 pandemic (10). As the transition from pandemic to post-pandemic circumstances occurs, these strategies may continue to be relevant as actionable ways of encouraging healthy screen time. In addition, mitigation strategies to reduce screen time should not fall entirely on caregivers; public health strategies to reduce infection rates during and following the pandemic need to consider unintended consequences of measures such as stay-at-home orders, physical isolation protocols, and distance-based online education on children (59).

When considered through the lens of the Bronfenbrenner's ecological systems theory (16), establishment of routines and limits contribute to the home environment and may also represent parents' attitudes towards screen use. These parental practices can therefore impact a child's relationship with screen use in the home environment and the broader environment beyond it. Our findings also align with those of previous studies

TABLE 2 Mixed effects models of associations between parental use of routines[a], limits[b], and child screen time by developmental age stages (3,628 observations).

	Screen time (min per day) during COVID-19								
	Unadjusted			Adjusted for covariates[c] – pre-COVID-19 screen time			Adjusted for covariates[c] + pre-COVID-19 screen time		
	B	95% CI	*p*-value	*B*	95% CI	*p*-value	*B*	95% CI	*p*-value
Routines									
<3 years (591 observations)	3.37	−3.52,9.17	0.36	5.08	−1.80, 10.84	0.13	4.61	−2.04, 10.39	0.16
3–4.99 years (907 observations)	2.65	−1.44, 7.28	0.26	2.29	−1.79, 6.74	0.32	2.10	−2.15, 6.28	0.36
≥5 years (2,130 observations)	4.84	1.50, 8.28	<0.01	5.25	2.24, 8.73	<0.01	5.25	2.25, 8.73	<0.01
Limits									
<3 years (591 observations)	3.26	−3.72, 8.65	0.41	3.77	−3.37, 9.34	0.32	3.41	−3.56, 8.86	0.39
3–4.99 years (907 observations)	0.88	−3.27, 5.82	0.77	0.34	−3.71, 5.28	0.90	0.03	−3.98, 4.82	0.99
≥5 years (2,130 observations)	2.70	−0.10, 5.34	0.05	2.98	0.09, 5.58	0.03	3.30	0.52, 5.90	0.02

[a]Question scale: throughout the day, I provide my child with 1 (a clear and orderly routine) to 7 (unstructured free time).
[b]Question scale: I am the kind of parent that 1 (sets limits on what my child is allowed to do) to 7 (lets my child do whatever he or she wants).
[c]Covariates: child sex, maternal ethnicity, most recently reported pre-COVID-19 family income, employment status during COVID-19 (repeated measures), number of siblings, number of screen devices at home, parental screen time during COVID-19 (repeated measures), stringent lockdown measures; results were stratified by age (<3, 3–4.99, ≥5 years) as defined *a priori* based on the child developmental age groups.

TABLE 3 Mixed effects models of associations between parental use of routines[a], limits[b], and meeting the Canadian 24-hour screen time guideline[c] (3,628 observations).

	Meeting the Canadian 24-Hour screen time guideline during COVID-19								
	Unadjusted			Adjusted for covariates[d] – pre-COVID-19 screen time			Adjusted for covariates[d] + pre-COVID-19 screen time		
	OR	95% CI	*p*-value	OR	95% CI	*p*-value	OR	95% CI	*p*-value
Routines									
<3 years (591 observations)	0.62	0.43, 0.89	0.01	0.55	0.35, 0.84	<0.01	0.59	0.38, 0.88	0.03
3–4.99 years (907 observations)	0.91	0.73, 1.10	0.35	0.94	0.75, 1.19	0.61	0.96	0.77, 1.23	0.75
≥5 years (2,130 observations)	0.79	0.68, 0.92	<0.01	0.75	0.65, 0.85	<0.01	0.76	0.67, 0.87	<0.01
Limits									
<3 years (591 observations)	0.64	0.43, 0.98	0.04	0.62	0.38, 0.96	0.04	0.65	0.39, 1.01	0.07
3–4.99 years (907 observations)	1.01	0.82, 1.24	0.93	1.06	0.86, 1.29	0.53	1.10	0.89, 1.35	0.38
≥5 years (2,130 observations)	0.92	0.83, 1.01	0.10	0.86	0.77, 0.94	<0.01	0.86	0.78, 0.94	<0.01

[a]Question scale: throughout the day, I provide my child with 1 (a clear and orderly routine) to 7 (unstructured free time).
[b]Question scale: I am the kind of parent that 1 (sets limits on what my child is allowed to do) to 7 (lets my child do whatever he or she wants).
[c]Canadian 24-Hour screen time guideline: 0 min for <1 years, 60 min or less for 1–5 years, and 120 min or less for >5 years.
[d]Covariates: child sex, maternal ethnicity, most recently reported pre-COVID-19 family income, employment status during COVID-19 (repeated measures), number of siblings, number of screen devices at home, parental screen time during COVID-19 (repeated measures), stringent lockdown measures; results were stratified by age (<3, 3–4.99, ≥5 years) as defined *a priori* based on the child developmental age groups.

that have found increases in child screen time from prior to during the COVID-19 pandemic (2–4). They also build upon those of previous studies that have examined the relationship between household chaos and child screen time (22, 23), where household chaos is characterized by factors such as high levels of background stimulation, lack of routine or structure in daily activities, and fast-paced family life (60, 61). In contrast to the study by Emond et al. (2018), which employed the Confusion, Hubbub and Order Scale to characterize household chaos, we did not observe sufficient evidence supporting a relationship between parental use of routines and child screen time in children <5 years. This may be due to insufficient power in our study and may also highlight the roles that other household chaos elements. However, our findings partially align with those of Kracht et al. (2021) for children ≥5 years, which observed an association between more household chaos and greater child screen time.

Our study's findings are also consistent with studies conducted prior to and during the COVID-19 pandemic that have observed greater screen time with less screen-related rules in children ≥5 years (17, 18, 20). However, our study found insufficient evidence of an association between parental use of setting limits and child screen time among children <5 years. This finding may be related to our stratification of analyses by the child developmental age groups, which provides granularity related to the varying abilities of the different developmental stages (50), at the expense of statistical power. It may also be partially explained by varying parental interpretations of what it means to set limits vs. screen-related rules for children at different developmental stages. For a child <5 years, "setting rules related to screens" and "setting limits" may be interpreted as very similar concepts. In contrast, parents may not set limits for their children <5 years because this age group is not yet highly autonomous nor independent, but they may have screen-related parenting rules that they follow to ensure their child is not exposed to screen time (51).

Notably, the estimated association between parental use of setting limits and child screen time was similar to that between parental use of routines and child screen time for children ≥5 years. This may be explained by correlation between routine and limit establishment and how they directly or indirectly relate to screen time. For instance, while limits are typically set for activities considered unhealthy and therefore often explicitly include screen time directly (62–65), routines regarding bedtime and physical activity are not directly related to but also appear to play a role in determining screen time among children (66).

The proportion of children meeting the Canadian 24-Hour screen time guideline varied by age group and was larger than that observed in other Canadian studies during the COVID-19 pandemic, though these studies focused on children and adolescents >5 years (67, 68). Compared to studies prior to the pandemic, similar or smaller proportions of participants in our study met the screen time guideline (6, 69, 70). Assessing the associations between parental routine and limit setting with meeting the guideline provides clinical relevance to the quantified changes in amount of screen time as it has been established that meeting the guideline confers a number of health benefits (3, 7, 8). Our findings suggest that parental use of routine and limit setting may play a positive role in helping children meet the screen time guideline, particularly among the older age groups of 3–4.99 years and ≥5 years.

This study is one of the first to evaluate the longitudinal link between parental use of routines and limits with child screen time during the COVID-19 pandemic. Strengths of this study include use of a cohort design, repeated measure to improve estimates of associations, and adjustment for multiple confounders including child screen time prior to the COVID-19 pandemic. Limitations include inability to make causal links between parental use of routines and setting limits with child screen time given its observational design and the potential of unmeasured confounders. Measures of the independent variables and outcomes were self-reported by parents and may have therefore been subject to self-reporting bias that could reduce the validity of the results. Furthermore, the measures represent parental perceptions and are

also subject to interpretation. As such, they may not correlate with objective measurement of the variables. Finally, this study is embedded in a primary care research network that mainly constitutes children of European ethnicity residing in an urban center and belonging to higher socioeconomic classes. Therefore, replications studies in different contexts are needed as the findings of this study may not be generalizable to other populations, such as lower income and rural or suburban populations.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Research Ethics Boards at The Hospital for Sick Children and Unity Health Toronto (TARGet Kids! Cohort Study #10000-12436 and #17-335). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

AL: Conceptualization, Formal Analysis, Methodology, Writing – original draft, Writing – review & editing. XL: Conceptualization, Methodology, Supervision, Writing – review & editing. CK: Conceptualization, Formal Analysis, Writing – review & editing. KC: Conceptualization, Writing – review & editing. LV: Conceptualization, Writing – review & editing. SC: Conceptualization, Writing – review & editing. JM: Conceptualization, Data curation, Supervision, Writing – review & editing. CB: Conceptualization, Data curation, Supervision, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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Association between the use of mobile touchscreen devices and the quality of parent-child interaction in preschoolers

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The early use of mobile touchscreen devices (MTSDs), including smartphones and tablets, may reduce the frequency and quality of social interactions between children and parents, which could impact their relationship and have negative consequences on children's socio-cognitive development. In this study, we applied a parental questionnaire and a behavioral observational method in a laboratory setting (free and structured play sessions) to examine the association between preschool MTSD use and the quantity and quality of parent–child relationships. Our findings revealed that preschoolers who regularly use MTSDs ($n = 47$, aged 4–7 years, engaging in MTSD use for at least 2 h per week) are spending less time with their parents and exhibited lower quality interactions compared to non-users ($n = 25$). However, shared offline leisure time with parents serves as a protective factor among MTSD-users. Furthermore, our study demonstrated a positive association between parents' and children's media use. The results suggest that preschool MTSD use may have unfavorable effects on parent–child interactions, both in terms of quantity and quality. Alternatively, lower quantity and quality of parent–child interaction may lead to higher MTSD use in the child. Based on the results, the importance of engaging in sufficient offline family interactions besides digital media use should be emphasized to parents of preschoolers, and health organizations and governments should include this in their recommendations and policies concerning childhood digital media use.

KEYWORDS

preschooler media use, mobile touchscreen devices, parent–child interaction, social interactions, smartphone/tablet use, online/offline activities

1 Introduction

Children usually form their first social impressions based on their interactions with their parents, and these early experiences have long-lasting effects on their social, cognitive and emotional development (1–3). For example, characteristics of early parent–child interactions shape the attachment style of an infant (4), that determines how they form relationships with others throughout their entire lives (5). Joint attention serves as the foundation for parent–child interactions, wherein partners pay attention to each other and redirect their focus to align with the other's attention (6). This facilitates the synchronization of actions, thoughts, and emotions (7–10). However, social situations that

would entail joint attention are often disturbed nowadays by the constant presence of attention-demanding, interrupting mobile touchscreen devices (*MTSDs*: tablets and smartphones).

The rapid increase of MTSD use is a global phenomenon. As of 2022, approximately 67% of the world's population (5.32 billion people) owned a mobile phone, spending around 6 h per day on the internet (11). These statistics indicate that MTSD use is a time-consuming activity that detracts from other aspects of life, including face-to-face social interactions (also known as the *social displacement hypothesis*) (12–16). Moreover, MTSDs and other digital devices not only affect the quantity but also the quality of social interactions (16). The term *technoference* describes the phenomenon whereby digital technology frequently interrupts our lives through beeping signals, incoming calls, or vibrations (17, 18). The disturbing effect of MTSDs is not limited to adult's social interactions (17): it is also observed in parent–child interactions, as demonstrated by several observational studies (19–26). For example, Lemish et al. (21) conducted a field study at a playground involving 60 families. The results showed that 79% of the parents used their mobile phones at least once during their stay at the playground. Based on the observations, alternated attention between the mobile and the child (*divided engagement*) and total absorbance by the MTSDs (*disengagement*) were found to pose safety risks, and the emotional well-being of the child was also compromised (21). Other studies also supported that parental MTSD use is associated negatively with parent–child interaction quality [for a review see (27)]. What further nuances the picture is that parents' absorption in their devices might serve as an undesirable model to follow (28, 29). In line with this, parents' heavy media use is associated with higher media use in children both in terms of TV (30) and MTSD use (29, 31, 32).

MTSD use in childhood is a booming phenomenon, more and more children use MTSDs around the world [e.g., in the UK (33), in the USA (34)]. Regarding the consequences of early MTSD use studies showed that excessive MTSD use of the child is adversely linked with parent–child relationship (although the causality is unknown) (35, 36). These findings may help explain why children who spend more time with digital media tend to perform worse on socio-cognitive and socio-emotional tests compared to non-user children (29, 37–42), and are more likely to experience relationship problems with their peers [(29) but see (43)]. In contrast, a week-long participation in an outdoor camp without access to MTSDs was associated with improved social perception skills at the end of the program (44). Finally, excessive engagement with digital devices not only distances the child from parents and peers but often leads to tantrums and serious conflicts within the family, further straining relationships (45–47).

To further complicate the already complex picture, the association between parent–child interaction and the use of digital devices by both partners can also be explained by reverse causality. The use of digital devices within a family may serve as an indicator of the family climate (48). For example, in families with loose bonds and less secure attachment, both parents and children may prefer digital devices or activities opposed to share time with each other (36, 49–52). Possible reasons for this behavior include compensating for the lack of social support (49), or coping with difficult emotions (53, 54). Additionally, if the child's MTSD use is unsupervised (how much and what contents they consume), it could end up in higher levels of and/or more problematic digital device use [for a review see (54)]. Therefore, lower parent–child interaction quality and quantity and excessive digital media use can have a bi-directional relation, leading to a vicious circle. Although digital device use might disrupt family interactions even in well-functioning, warm families, the engagement in sufficient joint offline interactions might protect children against becoming problematic MTSD users.

Nevertheless, so far only the parent's digital media use, but not the child's media use was observed in terms of its disrupting effects on the quantity and quality of parent–child interactions. As more and more children use MTSDs, and for an increasing amount of time (29, 55, 56), there is an urgent need to investigate whether this has negative effects on parent–child relationship, as it can have serious consequences on children's socio-emotional and socio-cognitive development.

Moreover, studies investigating MTSD use in childhood mainly focus on school-aged children or adolescents [e.g., (57–60)], despite the fact that more and more children become user at a younger age (29, 61, 62). Although children mainly use MTSDs actively at home, the presence of MTSDs is tend to become a common phenomenon in preschool classrooms, as well (63). It is worth highlighting that the preschool years are a sensitive period of life when the foundation of various cognitive skills are established [e.g., (64–66)]. For example, numerous studies investigate the link between media and MTSD use and the development of attention and executive functions [for a review see (66)]. There are also some studies using experimental design, that could show not only association but a direct effect, as well. In Lillard and Peterson's (67) study watching fast-paced videos lead to worse performance on tasks measuring executive functions in a group of 4-year-olds. Konok et al. (68) also found that playing with digital games affected attention at the age of 4–6 years. A further research area of this topic is whether ADHD (attention deficit hyperactivity disorder) or ADHD-like symptoms are related to early use of MTSDs. Results show a mixed picture, some studies found an association between MTSD use and ADHD (43, 69, 70), while others are not (71). Regarding social and emotional development, parents play a crucial role during the preschool years and before (72), and disturbances in family interactions, such as those related to MTSD use, may have consequences in later life. For example, Hinkley et al. (73) found that families with higher screen time during their child's early years do not support children's well-being as well as other families. Poulain et al. (74) also found that high screen time of mothers was associated with emotional problems. From a methodological point of view, the preschool period may be the last time in children's lives when non-users are available as a naturally formed control group, as non-users become a minority or a special group at later ages (e.g., children in alternative schools where MTSD use is forbidden).

Furthermore, although there is an increasing number of studies investigating the effects of MTSDs on families, particularly regarding parental MTSD use, these studies primarily rely on

parental questionnaires or observational data from field studies [for a review see (75)]. There has been a lack of controlled laboratory studies that directly observe and measure parent–child interaction.

1.1 Aims, hypotheses (H) and predictions (P)

In the present study, our aim was to investigate the association between the quality and quantity of the parent–child relationship and preschoolers' MTSD use. To achieve this, we compared the parent–child interaction in preschoolers who intensively use MTSDs (MTSD-users as follows) and preschoolers who do not use MTSDs at all (non-users). We were also interested in examining whether the parent–child relationship is linked to the child's problematic MTSD use and conflicts within the family regarding the child's MTSD use.

Based on our main hypothesis (H1) that MTSD use is negatively associated with parent–child interaction quantity and quality, we expected the following outcomes:

- Parent–child dyads in the MTSD-user group would spend less time engaged in shared free-time activities (P1), including joint offline activities (P2), but more or equal time engaged in joint online activities (P3) compared to dyads in the non-user group.
- Parent–child dyads in the MTSD-user group would exhibit lower-quality interactions in the laboratory setting compared to parent–child dyads in the non-user group (P4).
- We also predicted that among MTSD-users, problems related to MTSD use would be more prevalent in families where parents and children spend less time together engaging in offline leisure activities (P5).

Additionally, we hypothesized (H2) that there would be a positive association between parents' and children's digital media use, suggesting that MTSD use in children is associated with that of their parents.

2 Material and methods

Our study is part of a longitudinal experimental study containing two test sessions with a 2-month delay between them, in which the effect of an educational application was compared among three groups (an experimental MTSD-user group, an MTSD-user control group and a non-user control group). In the current study, we analyzed only the first session of the experiment (i.e., before any experimental treatment had occurred) and we merged the two MTSD-user groups in the analyses as we were interested in the differences between MTSD-users and non-users.

In the presented study we utilized a combination of questionnaire methods and controlled behavioral observations in a laboratory setting.

As children were randomly assigned to the experimental MTSD-user group and the control MTSD-user group, the two subgroups were similar in terms of any potential confounding effects before the treatment.

2.1 Participants

A total of 72 parent–child dyads participated in the study, with each dyad consisting of a child (39 boys and 33 girls) and one of their parents (10 fathers and 62 mothers). The inclusion criteria for the children encompassed an age range of 4–7 years, typical development without any developmental or psychiatric diagnoses, and specific digital activity parameters, which were assessed during the recruitment phase using a screening questionnaire (Supplementary Material Appendix 1).

In the non-user group, children were included if they had actively used MTSDs (passive use, such as watching videos, was not considered as an exclusion criterion) fewer than 5 times in their lifetime, according to the parents' responses. In the MTSD-user group, children were included if they met the following criteria: (1) using digital devices for a minimum of 2 h per week, (2) having a usage duration of at least 6 months, and (3) actively using the device, such as playing games on it.

The non-user group comprised 25 children (15 boys and 10 girls; mean age ± SD = 5.22 ± 0.69 years; range = 4.2–6.8 years), while the MTSD-user group comprised 47 children (24 boys and 23 girls; mean age ± SD = 5.38 ± 0.77 years; range = 4–6.8 years). The uneven sample sizes were a result of the study being part of a larger experimental study (as mentioned above). For more information about the demographic characteristics of the two samples see Supplementary Material Appendix 4.

Participants were recruited through online advertisements, and they received a small gift (e.g., pencils, toy cars, doll accessories, etc.) as a token of appreciation for their contribution. Data collection took place between September 2019 and August 2021 in Budapest, Hungary.

2.1.1 Ethical statement

Parents gave written informed consent, and before the experiment the experimenter explained the tasks to the children and their right to disrupt the study or take a break any time. The study was carried out according to national and international ethical standards (The Code of Ethics of the World Medical Association; Declaration of Helsinki) and was approved by the United Ethical Review Committee for Research in Psychology (EPKEB, permission no. 2019/17).

2.2 Materials and procedure

All tests were conducted in a child-friendly laboratory at the Eötvös Loránd University in Budapest, Hungary. The experiments were administered by one of five professional experimenters. Prior to the start of the test session, the experimenter provided information about the study to both the parent and the child, and written consent was obtained from the parent while oral consent was obtained from the child. The test session started with the Parent–Child Interaction Test. Following the interaction test, parents were asked to complete the Digital Media Use Questionnaire online using a tablet, while

their children participated in behavioral socio-cognitive tests that are not part of the current study.

2.2.1 Digital media use questionnaire (DMUQ)

We created the Digital Media Use Questionnaire (DMUQ) for this study partly based on the study of Konok et al. (29), consisting of 31 questions (Supplementary Material Appendix 2). The questionnaire has four main sections: (I) Demographic data of the family and parental digital behavior in the presence of the child; (II) Child's digital media use; (III) Problematic MTSD use; and (IV) Shared free time activities (online and offline). In the following description we highlight the questions involved in the current analysis.

2.2.1.1 Demographic data and parental digital media use in the presence of the child

Parents participating in the study were asked e.g., about their age, gender, highest level of education, and about the family's monthly net income (the answer was optional). Parents were also asked about their average daily use of TV, mobile phone, laptop/PC, and tablet in the presence of their child (in h and min). This section contained 13 questions. Most of the collected data did not require any conversation, only the average daily use was converted to h from the h and min format.

2.2.1.2 Child's digital media use

Questions were asked about the child's average daily use of TV, laptop/PC, mobile phone and tablet (in h and min). The answers were later converted to only hours. This section contained 7 questions.

2.2.1.3 Problems related to MTSD use

This section was displayed only for participants in the MTSD-user group.

Four questions measured, with a 5-point Likert scale, the frequency of conflicts about MTSD use, e.g., tantrums because of shutting down the device. Internal reliability of the four items was good (Cronbach Alpha = 0.8). An "MTSD conflict" scale was then created by summing up the scores of the four items (resulting in a range of 5–20 scores for this variable).

Likewise, four questions measured the child's behavior indicative of problematic MTSD use with a 5-point Likert scale, e.g., "My child wants to use MTSDs all the time". Internal reliability of the four items was high (Cronbach Alpha = 0.91), and again, responses were summed to create a "problematic MTSD use" scale with a range of 5–20 scores.

2.2.1.4 Shared free time activities between the parent and the child

Parents were asked five questions about the shared offline and online leisure activities with their child (such as types of joint activities, time spent together at weekdays/weekends). Shared online and offline leisure time variables were created from the weighted average of weekday and weekend data ($5 \times$ weekday + $2 \times$ weekend, divided by 7).

2.2.2 Parent–child interaction test (PCIT)

Parent–child interaction was investigated in two sessions: in a 5-min long free play session [based on (76)] followed by a 5-min long structured play session [based on (77)]. During the free play session, the experimenter left the room, but during the structured play session, she stayed for offering help if the participants had any problems.

2.2.2.1 Free play

Before the experiment one of two sets of toys (Set A and B, randomly assigned to the dyads) was put on a table; each set contained a storybook, memory cards, another card game, a puzzle, two toy cars, and 4 puppets (Figure 1). The experimenter showed the toys to the parent–child dyads and asked them to play with them for 5 min (until the experimenter returns). Then the experimenter started the video recording, left the room, and came back 5 min later.

2.2.2.2 Structured play

In the structured play task, we used a drawing toy named "Etch a sketch" (Figure 2). This toy consists of a board with two buttons and a screen. The left button controls vertical movement of a line on the screen, while the right button controls horizontal movement. Simultaneously turning both buttons results in a diagonal line. Prior to the task, the dyads were provided with an explanation of how the toy works. They were then instructed to each control one of the buttons (e.g., child controls the left button, parent controls the right button) and collaboratively draw a pine tree (Task A) or a house (Task B). The assignment of tasks was randomly determined for each dyad. Both tasks required the parent and child to synchronize their movements and cooperate in drawing diagonal lines. If the dyads completed their assigned drawing in under 5 min, they were given the option to continue playing and draw anything they desired. The session was video recorded (drawings were not evaluated for the study, only behaviors displayed during the task).

2.3 Coding

Video recordings were analyzed using Solomon Coder (© András Péter). Through an exploratory video analysis, we identified recurring actions that could indicate the quality of parent–child interaction. In total, 36 variables were created: 19 behavioral variables for the Free play session and 16 behavioral variables for the Structured play session. (Supplementary Material Appendix 3 provides a comprehensive list of variables and their definitions).

Some of the variables were categorized as *instant*, meaning that we coded only the occurrence of the action, and these occurrences were summed up to obtain a frequency count variable. Other variables were classified as *continuous* where the duration of the action was measured, and a time percentage was calculated. This percentage represents the proportion of the entire session that participants spent engaged in the given action.

FIGURE 1
Object set A offered for free play during the first session of the parent–child interaction test.

FIGURE 2
"Etch a sketch" game, used for the structured play during the second session of the parent–child interaction test.

To ensure reliability, six coders who were blind to the grouping of the dyads underwent training for video coding. Each coder was responsible for coding a specific number of videos: Coder 1 coded $N = 2$ videos, Coder 2 coded $N = 7$ videos, Coder 3 coded $N = 18$ videos, Coder 4 coded $N = 14$ videos, Coder 5 coded $N = 19$ videos, and Coder 6 coded $N = 8$ videos. Inter-rater reliability was assessed for 20% of the videos, with two coders independently coding the same videos. The results indicated satisfactory reliability. Cronbach's Alpha for the instant variables ranged from 0.72 (Action by child [fp]) to 1 (No answer [fp]), while Cronbach's Alpha for continuous variables ranged from 0.77 (Joint attention [fp]) to 0.91 (Child laughs [fp]).

2.4 Statistical analysis

IBM SPSS for Windows, Version 28.0 (Armonk, NY: IBM Corp.) was used for statistical analysis.

Normality tests (Shaphiro–Wilk) were conducted to analyze demographic and media use characteristics of MTSD-users and non-users (see results in the Supplementary Material Appendix 5).

Independent samples *t*-tests were used to compare MTSD-users and non-users regarding parental education, monthly net income, TV watching and shared offline and online leisure time, both separately and summarized (shared offline and shared online time together).

Principal Component Analysis (PCA) with Varimax rotation was used to reduce the number of behavioral variables in the Parent–Child Interaction Test and identify dimensions of parent–child interaction quality. Variables of free play and structured play were involved together in the analysis. A variable was retained if it had 0.4 or higher loading on the respective principal component. Items with a 0.4 or greater loading on more than one component were considered as cross-loadings and were removed. The number of final components was determined based on both the eigenvalues (greater than 1) and the scree plot.

Generalized Linear Models (GzLMs) were applied for investigating the association between each principal components (dependent variables) of the PCIT and experimental group (MTSD-user/non-user) as independent variable. The following potential confounding variables were also included in initial models: parent age, parent gender, parent education, parent net income, child age, child gender, existence of older sibling(s), shared digital activity, shared offline activity, freeplay set (A/B), and structured play task (A/B).

In MTSD-users ($N = 48$), ordinal logistic Generalized Linear Models (ordinal GzLMs) were used to identify the possible associations between problems related to MTSD use (MTSD conflict and problematic MTSD use; dependent variables in separate models) and other variables from the DMUQ (child's gender, child's age, parent's gender, parent's age, parent's education, child's media consumption [summarized], shared offline activities and shared online activities) as independent variables. In all models (GzLMs and ordinal GzLMs), stepwise model selection with backwards elimination was used based on *p*-values.

Associations between parents' and children' media consumption (average daily use) were analyzed separately for all devices (TV, mobile phone, tablet) and together as a total media consumption, using bivariate correlation analysis (Spearman).

3 Results

3.1 Demographic and media use differences between MTSD-users and non-users (based on DMUQ))

3.1.1 Comparison of indicators of the socioeconomic status (SES) between MTSD-user and non-user groups

We compared whether there is a difference between the two groups regarding the education of the parents and the families' monthly net income. The groups differed in parental education ($U = 357.5$, $p < .01$). Results showed that parents in the non-user group (M ± SE = 3.77 ± 0.97) were more educated than parents in the MTSD-user group (M ± SE = 3.07 ± 1.12). In the monthly net income there was not any difference between the two groups ($t_{62} = -1.44$, $p = .078$; MTSD-users: M ± SE = 531 714 HUF ± 210 023 HUF; non-users: M ± SE = 617 272 HUF ± 254 804 HUF).

3.1.2 Comparison of TV watching between MTSD-user and non-user groups

Regarding TV watching MTSD-users watch TV more than non-users ($t_{70} = -3.34$, $p < .01$).

3.2 Child's MTSD use and the quantity of parent–child interactions (based on DMUQ)

Non-user parent–child dyads spent more time (M ± SE = 4.45 ± 0.37 h/day) with joint leisure activities compared to dyads in the MTSD-user group (M ± SE = 3.58 ± 0.21 h/day; $t_{70} = 2.18$, $p = 0.033$; P1). This was due to non-user dyads spending more time with joint offline activities (non-user M ± SE = 3.94 ± 0.39 vs. MTSD-user M ± SE = 2.82 ± 0.17 h/day; $t_{70} = 2.83$, $p = 0.006$; P2) as opposed to spending less time with shared online activities (non-user M ± SE = 0.5 ± 0.1 vs. MTSD-user M ± SE = 0.76 ± 0.08 h/day; $t_{70} = -2.10$, $p = 0.039$; P3) (Figure 3).

3.3 Child's MTSD use and the quality of parent–child interaction (based on PCIT)

3.3.1 Principal component analysis of the parent–child interaction test

The PCA of the Parent–Child Interaction Test resulted in 5 components, which explained 61% of the total variance. The five principal components were interpreted as *shared fun* (e.g., both parent and child are laughing), *interactivity* (e.g., the child

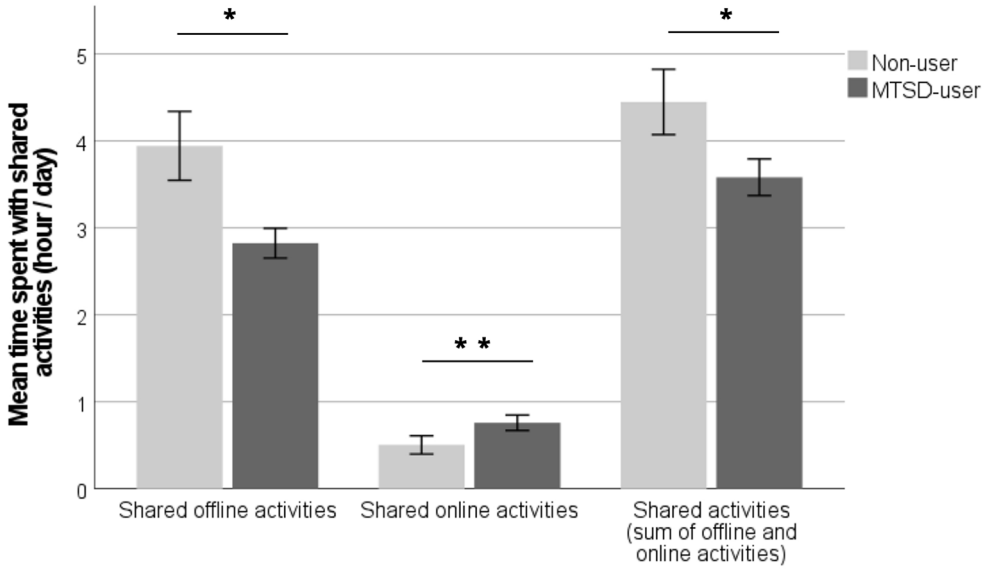

FIGURE 3
Mean time + SE (h/day) spent together with offline and online activities (separately and in total) in non-users and MTSD-users. Significant results are indicated with asterisks (**$p < .01$; *$p < .05$; ns = non-significant, $p > .05$).

initiates actions, and the parent responds to it), *parental control* (parent directs the attention of the child verbally and physically), *attention towards partner* (e.g., parent and child look at each other during tasks), and *collaboration* (working together on the task) (see Supplementary Material Appendix 6 for items and their loadings on the respective components).

3.3.2 Association of child's MTSD use and parent–child interaction quality

3.3.2.1 Shared Fun

Only child's age had a marginal positive effect on *shared fun* ($B \pm SE = 0.01 \pm 0.004$, $\chi^2_{1,\ 63} = 3.71$, $p = 0.054$). The other variables (including MTSD use) had no significant effect on the *shared fun* component (all $p > 0.075$).

3.3.2.2 Interactivity

Parent–child dyads in the non-user group were more interactive during shared play sessions than dyads in the MTSD-user group ($B \pm SE = 0.08 \pm 0.03$, Wald $\chi^2_{1,\ 63} = 7.45$, $p = 0.006$). Shared online activity ($B \pm SE = -0.23 \pm 0.09$, Wald $\chi^2_{1,\ 63} = 6.14$, $p = 0.013$), and parent's education were both negatively associated with the interactivity component ($B \pm SE = -0.43 \pm 0.01$, Wald $\chi^2_{1,\ 63} = 9.37$, $p = 0.002$). Parent's gender had a significant effect due to fathers having higher interactivity scores than mothers ($B \pm SE = 0.12 \pm 0.04$, Wald $\chi^2_{1,\ 63} = 9.34$, $p = 0.002$). Task B in structured play was associated with higher scores on interactivity ($B \pm SE = -0.69 \pm SE\ 0.03$, Wald $\chi^2_{1,\ 63} = 6.16$, $p = 0.013$). (This fact did not influence the results as the ratio of children receiving A and B task was the same in users [24:23] and in non-users [12:13].) The other variables had no significant effect on the Interactivity component (all $p > 0.24$) (Figure 4).

3.3.2.3 Parental control

Parents in the non-user group tended to show more control than parents in the MTSD-user group, although this effect was not significant ($B \pm SE = 0.03 \pm 0.02$, Wald $\chi^2_{1,\ 63} = 2.9$, $p = 0.088$). Structured play task A was associated with more parental control ($B \pm SE = 0.04 \pm 0.02$, Wald $\chi^2_{1,\ 63} = 4.42$, $p = 0.035$) than task B. The other variables had no significant effect on the Parental control component (all $p > 0.28$) (Figure 4).

3.3.2.4 Attention towards partner

Dyads paid more attention towards each other in the non-user than in the MTSD-user group ($B \pm SE = 0.04 \pm 0.02$, Wald $\chi^2_{1,\ 63} = 3.92$, $p = 0.048$). Shared online activity had a positive ($B \pm SE = 0.13 \pm 0.07$, Wald $\chi^2_{1,\ 63} = 3.84$, $p = 0.05$), whereas child's age had a negative effect on this component ($B \pm SE = -0.29 \pm 0.01$, Wald $\chi^2_{1,\ 63} = 4.79$, $p = 0.029$). The other variables had no significant effect on the Attention towards partner component (all $p > 0.123$) (Figure 4).

3.3.2.5 Collaboration

None of the investigated variables explained variation in the Collaboration component (all $p > 0.113$).

3.4 Problems related to MTSD use and the quantity of parent–child interactions (based on DMUQ)

3.4.1 MTSD conflict

Analyzed in MTSD-users ($N = 48$), shared offline activities were negatively associated with MTSD conflict score ($B \pm SE = -1.77$, ± 0.68, Wald $\chi^2_{1,\ 48} = 6.74$, $p = 0.009$). Parents'

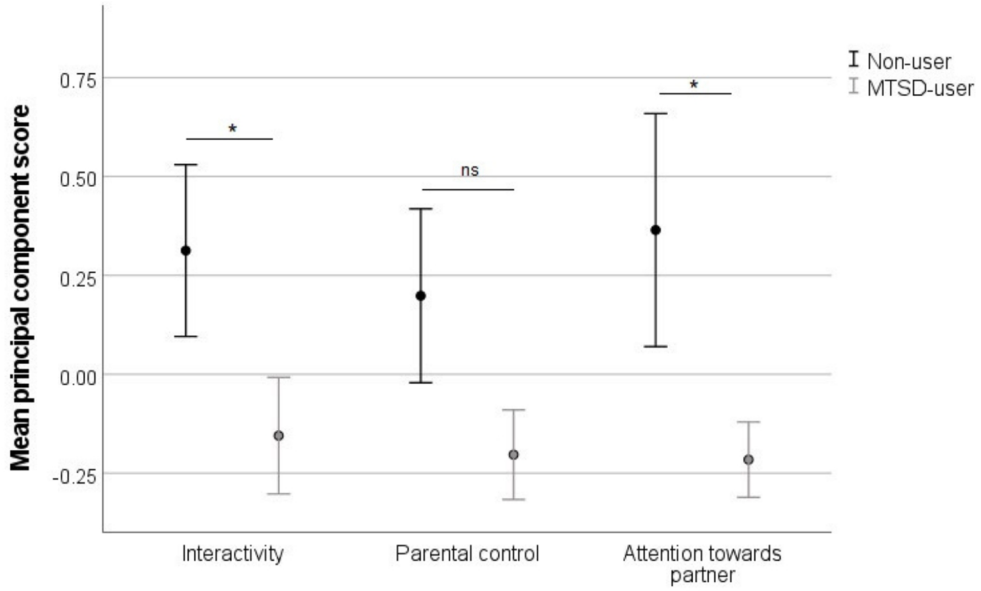

FIGURE 4
Mean scores and error bars of the interactivity, parental control and the attention towards partner principal components in the non-user and MTSD-user groups. Significant results are indicated with asterisks (**$p < .01$; *$p < .05$; ns = non-significant, $p > .05$).

education had a positive effect on MTSD conflict scale (B ± SE = 0.6 ± 0.24, Wald $\chi^2_{1,\ 48} = 6.54$, $p = 0.011$), so that higher educated parents experienced more conflicts about MTSD use. The other variables (child's gender, child's age, parents' gender, parent's age, child's media consumption, shared online activities) had no significant effect on MTSD conflict score (all $p > 0.296$).

3.4.2 Problematic MTSD use

Shared offline activities were negatively associated with the problematic MTSD use score (B ± SE = −1.64 ± 0.69, Wald $\chi^2_{1,\ 48} = 5.66$, $p = 0.017$). Both parent's education (B ± SE = 0.93 ± 0.29, Wald $\chi^2_{1,\ 48} = 10.44$, $p < 0.001$), and child's total media consumption (Wald $\chi^2_{1,\ 48} = 5.16$, $p = 0.023$) had significant positive effect on problematic MTSD use. The other variables (child's gender, child' age, parents' gender, parent's age, shared online activities) had no significant effect on problematic MTSD use score (all $p > 0.098$).

3.5 Associations between digital media use of the parent and the child (based on DMUQ)

The child's total media consumption was significantly correlated with that of the parent (Spearman's $r = 0.63$, $p < 0.001$). When analyzing the correlations separately for each device, only time spent on watching TV correlated between the parent and the child (Spearman's $r = 0.59$, $p < 0.001$). The use of other devices was not correlated (all $p > 0.13$).

4 Discussion

In our study, associations between preschool MTSD use and the quantity and quality of parent–child relationships were revealed via questionnaire method and also in an observational, laboratory environment. Although the applied method is not suitable for describing the possible direct effects of childhood MTSD use on relationships, the results emphasize the importance of investigating childhood MTSD use as a factor regarding the quantitative and qualitative evaluation of family relations. Moreover, the timing of this investigation should start as early as possible, as based on the results the influence of MTSD use is present already during the preschool years, if not earlier [e.g., see (78–80)].

Generally, our results also highlighted the role of shared offline activities as these activities could be considered as a protective factor against problematic MTSD use, and a facilitator of forming high quality relationships among family members. It is worth to note that based on our results shared online activities seem to be less effective despite of the shared component.

4.1 Child's MTSD use and the quantity of parent–child interactions

Parent–child dyads in the MTSD-user group spent less time engaging in joint leisure activities, including fewer offline activities, but they spent more time participating in shared digital activities compared to dyads in the non-user group. This finding supports the social displacement hypothesis, suggesting that children who use MTSDs may have less time available for other activities, including offline activities with family members.

Additionally, this study corroborates previous research indicating that children who use MTSDs tend to have parents who also engage in higher levels of digital media use [see also (32, 81, 82)]. Consequently, both the child and the parent may have less time dedicated to offline social activities. Furthermore, reduced social interactions within the family, which can indicate lower quality relationships, might lead to increased digital media use as a compensatory or coping strategy (31).

Although dyads in the MTSD-user group spent more time engaging in shared online activities compared to dyads in the non-user group, the overall average time spent on shared online activities for both groups was considerably lower than the time spent on shared offline activities. Therefore, the additional time spent on joint online activities by users compared to non-users is relatively insignificant (the mean for users is only 0.26 h higher than that of non-users), while non-users spend over 1 h more per day on joint offline activities compared to MTSD users. Additionally, research suggests that online/digital parent–child activities are generally of lower quality than offline activities (83) indicating that children in the MTSD-user group are likely participating in fewer high-quality social interactions that are essential for the development of secure attachment and socio-cognitive skills (84, 85).

4.2 Child's MTSD use and the quality of parent–child interaction

Our laboratory test results indicate that parent–child dyads in the MTSD-user group exhibited lower-quality interactions compared to dyads in the non-user group. Specifically, we observed differences in three out of the five dimensions of parent–child interaction related to quality: interactivity, attention towards the partner, and marginally parental control.

4.2.1 Interactivity

Children in the non-user group demonstrated higher levels of initiation in interactions, such as asking questions, seeking the parent's attention, and providing instructions, while parents in this group responded more frequently and warmly, including praising the child. These findings align with previous research that suggests a link between digital media use and lower quality interactions (16, 46). However, it remains unclear whether MTSD use is a cause, an effect, or simply a symptom of less strong family relationships. Additionally, it is plausible that engaging in MTSD use as a solitary and time-consuming activity adversely impacts the development of socio-emotional and socio-cognitive skills by displacing social interactions and non-digital play, thereby further hindering the establishment of relationships with others (68, 86).

Furthermore, the results indicated a negative association between shared online activity and the *interactivity* component of parent–child interaction. This suggests that online activities, even when shared with the parent, cannot compensate for the quality of offline shared time. Online and offline shared activities differ significantly: when media is involved, parents tend to be more passive (16, 87). Shared video watching invokes less interaction compared to reading a book or a role play game (88). Parents who co-use media with children, give fewer verbal utterances during electronic play compared to toy play or reading (78, 87, 89–91). This could be also true for digital games, where the parent might only watch how the child plays, but not participate in it actively (92). During joint offline activities, parental scaffolding (assistance) may create opportunities for high quality interactions, such as asking questions, labelling objects and being verbally affectionate (93). However, digital devices themselves may offer children suggestions and feedback to scaffold children's use (94), making parental scaffolding less needed (83). Additionally, younger generations are often more proficient in using digital technology ("digital natives") than their parents' generation ("digital immigrants") [for a review see (95)], which further restricts parental scaffolding opportunities.

Surprisingly, parent's education was negatively associated with the *interactivity* parameter. Higher-educated parents may exhibit higher levels of perfectionism and sensitivity to social acceptance (96, 97), which could have made the testing environment more uncomfortable and stressful for them, resulting in lower quality interactions.

Lastly, parent's gender was also associated with the *interactivity* component, with father-child dyads demonstrating higher levels of interactivity compared to mother–child dyads. This finding aligns with previous research of Lindsey et al. (98), which showed that fathers tend to be more initiative and provide more polite commands and imperatives during play with their children compared to mothers. However, it is important to note that the limited representation of fathers in our study (only 10 fathers) raises the possibility of non-representative sampling regarding fathers.

4.2.2 Attention towards partner

Consistent with the findings on *interactivity*, the results also support the social displacement theory, as *attention towards partner* was higher in the non-user group compared to the MTSD-user group. The reduced parent–child interactions due to MTSD use may have a negative impact on the attachment relationship between the child and the parent, as reflected in the diminished dyadic attention, which is a fundamental aspect of social relationships (99). Dyadic attention is crucial for sharing emotions and achieving intersubjectivity, forming the basis for socio-cognitive and socio-emotional development (100). Alternatively, weaker connections (as expressed also by less dyadic attention) among the family members may lead to increased digital device use (31), also in case of the child.

The item *joint attention* loaded negatively on the *attention towards partner* component, indicating that dyads in the MTSD-user group not only spent less time paying attention to each other but also spent more time engaged in joint attention. This may appear contradictory, as joint attention is typically regarded as an indicator of intersubjectivity and a key aspect of social relationships. However, in our coding, we considered behaviors as *joint attention* when both the child and the parent looked at the toy simultaneously. Therefore, these behaviors and *attention towards partner* are mutually exclusive, explaining the opposite

loadings on the same principal component. Furthermore, our definition of *joint attention* did not include gaze alternation between the object and the partner, but solely focused on joint attention to the toy. As a result, this behavior may not necessarily indicate a strong social connection, but rather suggests that dyads in the MTSD-user group may prioritize focusing on the object of play rather than on each other.

Interestingly, shared online activity was positively associated with the *attention towards partner* component, seemingly contradicting the previous result (negative link between the child's MTSD use and attention towards the partner) and the findings regarding the *interactivity* component (i.e., that shared online activity was negatively associated with the *interactivity* component). It is possible that even though online activities may not facilitate direct interaction between partners, the physical closeness inherent in shared online activities may enhance attention towards the partner. Additionally, shared online activities cover several different activities (e.g., co-viewing TV might have very different effect on social interactions than co-playing digital games), which the present study does not separate. In addition, while the *interactivity* component has strong association with both the child's MTSD use and the shared online activities, the *attention toward partner* component's association with these variables were barely significant, thus, it should be interpreted cautiously.

4.2.3 Parental control

Parental control was slightly higher in the non-user group compared to the MTSD-user group. This may indicate that parents of non-user children are generally more concerned and restrictive, not only regarding MTSD use but also in other areas of their children's lives. This hypothesis could be supported by the result showing that parents of non-users were more educated than parents of MTSD-users. It is possible that higher educated parents have more information about the adverse effect of MTSD use resulting stricter parental rules for the benefit of the child. Generally, higher parental control regarding digital media consumption, including TV watching, internet use, and MTSD use, have been found to be associated with lower screen time, internet use, and MTSD use among children (29, 101, 102).

According to the theory of Baumrind (103), control is one of the dimensions that determine parenting style, with the other dimension being warmth or responsiveness, which is also indicated by the components of *interactivity* and *attention towards partner* in the non-user group. The combination of high demands and responsiveness characterizes authoritative parenting style. Authoritative parents respect their child's opinions while maintaining clear boundaries. They foster their child's demands through bidirectional communication, such as explaining rules, and encourage independence. Authoritative parenting style is associated with the most favorable developmental outcomes for children (104). Therefore, while the MTSD use of family members may decrease the quality of parent–child interactions, the reverse relationship is also highly plausible. In this scenario, a favorable parenting style leads to higher quality parent–child interactions, including more secure attachment, which, in turn, promotes healthier behavior, such as reduced or delayed MTSD use in early childhood or less problematic digital device use in later stages of development (105, 106).

4.2.4 Shared fun and collaboration

We did not find any difference between dyads in the MTSD-user and non-user groups in the *shared fun* and *collaboration* component. A high score on *shared fun* indicates that both the parent and the child laughed frequently during the play sessions, and the parent initiated new activities often in the Free play session. While laughter can be indicative of warmth in the relationship, it can also indicate embarrassment, due to feeling observed or showing lower skillfulness in the "Etch-a-sketch" game, which introduces uncertainty in interpreting this component. Additionally, the high loading of parental action initiation further complicates the interpretation.

A high score on *collaboration* suggests that both the parent and the child scrolled the buttons of the "Etch-a-sketch" game parallel, rather than just the child scrolling it. It is expected that *collaboration* would be higher in the non-user group, indicating higher levels of cooperation. However, the interpretation of this component is also ambiguous because alternate scrolling, where the child and the parent take turns scrolling in a synchronized manner, can also indicate cooperation. Unfortunately, our coding and analyzing methods did not allow us to assess alternate scrolling, which should be considered in future studies.

4.3 Problems related to MTSD use and the quantity of parent–child interactions

The importance of shared offline activities is also highlighted by our results on problems related to MTSD use. Both the scale of *conflict about MTSD use* and *problematic MTSD use* showed lower scores among MTSD-users when children shared more time with their parents offline. Children frequently interacting with their parents generally have fewer behavioral and peer-relationship problems (74), but based on a study by Beyens and Beullens (46), children co-using digital devices with parents also have less conflicts about media use compared to children who use MTSDs alone (in our case, time spent with shared online activities was unrelated to problematic MTSD use). This suggests that good parent–child relationship can be a protective factor against problematic media use, while a disadvantageous family environment can increase the chances for more frequent and serious problems related to MTSD use [for a review see (54)]. The result also highlights that MTSD use in young children may be unfavorable only if it substitutes (takes time away from) good-quality offline interactions with parents.

Interestingly, parent's education was also associated positively with problematic MTSD use (both scales). Highly educated parents might be more concerned with their child's MTSD use resulting in more conflicts and higher awareness of the child's problematic media use. In accordance with the results, higher educated parents control more their children's internet use (101), and MTSD use (29) than lower educated parents.

4.4 Associations between digital media use of the parent and the child

Our results supported our hypothesis that media consumption in parents and children are associated. This result is in line with previous studies showing that parents function as a role model for children in digital media use (29, 31, 32, 81). In addition, parents with a positive attitude about MTSDs also tend to encourage their children to use them (107). Finally, it is also possible that parents' heavy MTSD use takes time away from shared activities with their children, and children end up using MTSD as well. As we mentioned earlier, problematic MTSD-use could concern also adults' life with consequences on their well-being and relationships (108–110).

4.5 Limitations

One limitation of the study is that it only examines associations and cannot establish causality regarding the parent and child's digital media use and their interaction quantity and quality.

Another limitation is that both the free play and structured play settings in the study were designed with offline activities, and no digital activities were included. The addition of a shared online task could have provided insights into whether interaction patterns differ between online and offline tasks, as observed in previous studies (111). However, introducing an online task may raise ethical considerations, particularly in the non-user group where parents may have reservations about digital media use. Additionally, the lack of experience with digital media in the non-user group could potentially impact the evaluation of the test, as it may be perceived as highly interesting and exciting by the child.

On the other hand, the "Etch a sketch" game contains a screen, and the image displayed there changes as a result of the users' actions, which is very similar to what happens on the screen of digital devices. Therefore, MTSD-users might have advantage on this game, and this might have influenced the results (e.g., the child has to ask fewer question, the parent has to exert less control, etc.). Although the inclusion of the free play session with screen-free toys reduces the likelihood of this explanation, future studies should clarify this issue more systematically.

Although the two tasks offered in the structured play session were aimed to be of similar kind and difficulty, the results revealed a difference in the interactivity parameter during the execution of these tasks. It is possible that the two tasks differed in difficulty, but this disparity could not affect the results, as the distribution of tasks was balanced between users [24:23] and non-users [12:13].

Furthermore, a limitation of the Parent–Child Interaction Task (PCIT) and the Digital Media Use Questionnaire (DMUQ) used in the study is that they have not yet been validated. To use these measures in future studies, a validation process is necessary to establish their reliability and validity.

Further research, including longitudinal studies and validated measurement tools, is needed to provide a more comprehensive understanding of the relationship between parent–child interactions and digital media use.

5 Conclusion

Our study findings suggest that childhood digital media use is associated with reduced quantity and quality of interactions with parents. The decrease in quality time spent together could also increase conflicts related to MTSD use and a higher likelihood of problematic MTSD use. This study highlights the importance of considering the child's media use as a component when investigating the quality of parent–child interactions both in scientific research and also in the applied sciences like psychology or pedagogy, as the presence of MTSDs can have an impact even during the preschool years.

Furthermore, our results indicate that problematic MTSD use is a family-wide concern, as parents' MTSD use was associated with their children's MTSD use. This issue should be treated seriously, considering that the family serves as the primary social platform for a child and significantly influences the quality of future relationships. Therefore, managing early MTSD use requires a systematic approach that supports not only the focal child but also other family members.

Finally, parents' attention should be drawn to the fact that engaging in joint offline activities with their children are important not only in promoting communication and strengthening social relationships, but also in decreasing the chance of problematic MTSD use of the child. Parents' role in demonstrating responsible and mindful media use should be also highlighted. By implementing these strategies, parents can effectively navigate the challenges posed by digital media and cultivate a healthy and enriching environment for their children's development.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by United Ethical Review Committee for Research in Psychology (EPKEB). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

KL-P: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Writing –

original draft. ZsB: Investigation, Project administration, Writing – review & editing. AK: Investigation, Project administration, Writing – review & editing. ZsJ: Software, Writing – review & editing. ÁP: Writing – review & editing. GyK: Funding acquisition, Software, Writing – review & editing. ÁM: Funding acquisition, Writing – review & editing. VK: Conceptualization, Funding acquisition, Supervision, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/frcha.2024.1330243/full#supplementary-material

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Effects of digital and non-digital parental distraction on parent-child interaction and communication

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Technoference, namely parental screen use in the presence of a child, is a widespread phenomenon that has negative effects on parent-child interaction and communication. When parents use screens around their children there are fewer interactions and parents are less contingent and responsive to the child. Additionally, children show more negative behaviors, such as whining, frustration, and outbursts. Communication is also affected—parents speak and gesture less towards their children and, in turn, children are less likely to develop their language abilities. It remains unclear, however, if parental distraction due to screen use affects parent-child interaction and communication more negatively compared to non-digital parental distraction. Fifty-two parent-child dyads (mean child age = 22 months, range 12–36 months) first played for 5 min (Time 1); then (Time 2), the parent was asked to fill out a questionnaire on a tablet (screen condition), on a printed form (paper-pen condition) or was not interrupted (control condition). Interactive quality was assessed at Time 1 and Time 2 using the Coding Interactive Behavior scale. Communication was assessed by coding the number of word tokens and types during Time 1 and Time 2; child gestures were also coded. Results revealed that when parents were distracted—either by the paper-pen or the screen questionnaire—the quality of the interaction significantly deteriorated ($p_s \leq .01$) and the quantity of parental communication significantly declined ($p_s \leq .012$). Importantly, the nature of the distraction did not matter: there were no significant differences between the paper-pen and the screen distraction conditions across Time 2 ($p_s \geq .59$). Findings suggest that parental distraction matters for the quality of interaction and the amount of communicative bids, independently on whether parents were distracted by a digital or non-digital activity. These findings likely relate to complex factors related to young children's experiences and habits with parental screen use.

KEYWORDS

screen, technoference, toddlers, interaction, language

Introduction

Young children rely on interactions with their parents in order to learn and develop their social and emotional skills. When parent-child interactions are disrupted—such as when the parent is being distracted by using a screen—the interaction is negatively affected. In the current study, we test how different parental distractions may disrupt the quality and quantity of interactions between parents and their toddlers. Specifically,

we ask whether parental distraction from a screen activity leads to lower quality of the interaction and to less communicative exchanges between the parent and the child than parental distraction from the same activity on paper-pencil.

Technoference

Digital devices are ubiquitous: people across all ages, all cultures and all socioeconomic backgrounds are using digital media on an everyday basis. For smartphones only, 82% of French families (1) and 97% of the Swiss population (2) own at least one device. Digital devices are not only widespread; they are also highly used. Accordingly, French adults use digital media for 5 h/day [France (3)], whereas this duration almost doubles for American parents [i.e., 9 h/day (4)].

Yet, when a parent uses a digital device in the presence of a child, the nature and quality of the parent-child interaction are impacted (5). In fact, interactions are frequently interrupted when parents use a screen technology. Radesky and colleagues were the first to operationalize parents' level of device use during parent–child interaction as "the extent to which the primary focus of the caregiver's attention and engagement was with the [digital] device rather than the child" (2014, p. 845). Later on, McDaniel (6) coined the term "technoference" or "technology interference" to describe the situations when digital media intrude and interrupt parent-child interactions and communications. In an American survey, 68% of parents indicated that they feel distracted by their smartphone when spending time with their children (7). Such self-reports are supported by systematic observations: 73% of parents have used their smartphone while in a fast food restaurant with their children (8).

Given that technoference is not an isolated phenomenon, studies have examined the implications of technoference on children. Beyond issues related to safety concerns (9), there is emerging evidence that parental screen use around children might negatively influence child's development. A particular emphasis is put on young children (0–3 years) given the importance of parent-child interactions on early psychological development.

Effects of technoference on parent-child interactions

Interactions between parents and infants play a crucial role in supporting various aspects of the child's development (10). These interactions enable young children to develop their social awareness through continuous and mutually responsive exchanges with their parents (11, 12). Additionally, sensitive parent-infant interactions lay the groundwork for forming secure attachment bonds (13, 14). As a result, the children's growing social awareness and attachment provide the basis and incentive for them to explore and learn about the world, foster healthy social and emotional growth (15), acquire language and communication skills (16, 17), gain insights into themselves and others, and establish positive social connections.

A crucial aspect of the quality of parent-child interactions is the ability of parents to detect, acknowledge and respond to child's behavior and communicative bids [i.e., parental sensitivity (18, 19)]. There is broad consensus that parental sensitivity is crucial for child development (20). However, when parents' focus of attention shifts to a digital device instead of the child (i.e., technoference), their ability to be sensitive and responsive to their children is negatively impacted.

Research shows that when parents use screens in the presence of their child, there are fewer interactions (21, 22) and parents are less contingent and responsive to the child's behavior (9, 23–27). For example, studies looking at parents in public places show that lack of sensitivity to the child, such as not noticing signs of emotional distress, increases in parents who use a smartphone, compared with those who don't (28, 29). A similar finding, but relating to duration of use, is reported in studies by Tharner and colleagues (30) and Wolfers and colleagues (31). In these studies the authors show that the longer parents use their smartphones, the less sensitive they are to their child. Additionally, technoference is related to increases in the number of conflicts with the child, the number of negative behaviors towards the child (8) and the dissatisfaction of the time spent with the child (21).

Parental screen use during parent-child interactions also affects the child. Technoference is associated with both more internalized behaviors, such as whining or pouting, and more externalized behaviors, such as agitation, frustration and outbursts (32–34). Children show more negative affect and less positive affect when their mother uses a screen during interaction (35). In addition, children show more behaviors to attract their mother's attention during an interrupted mother-child interaction with a screen compared to an uninterrupted interaction (36). A recent experimental study shows that technoference affects infants' physiological reactivity (i.e., increased heart rate), suggesting that this may be a stressful context (37).

Effects of technoference on parent-child communication

In the first years of life, parent-child interactions provide the foundations of young children's communicative development. Stemming from the Transactional Theory in child developmental (38), the importance of face-to-face parent–child interactions in the development of communication in early childhood is widely recognized (39–42). Mounting evidence establishes direct links between the parental communicative input and young children's both verbal and non-verbal communication abilities. Namely, individual differences in maternal gesture rates correlate with their infants' own gesture (43, 44) and parents who direct more speech to their children have children showing faster and larger vocabulary growth (45, 46).

There is empirical evidence showing that technoference affects parental communicative input towards young children (47). In a

study with 6-year-old children, Radesky et al. (22) found that mothers who used their phone during the observation session spoke less and made fewer nonverbal gestures to their children (80% of the utterances and 61% of the nonverbal gestures compared to those who did not use phones). Importantly, findings of Reed et al.'s laboratory study showed that technoference affected vocabulary acquisition in toddlers. Specifically, 2-year-olds were less likely to learn a novel word taught by parents when they were distracted by a 30-sec phone call compared to peers whose parents were not interrupted (48). More recently, it has been shown that the amount of audible notifications parents report receiving per hour was negatively associated with infants' vocabulary in controlled observations of 18- to 25-month-olds from New Zealand (49).

The current study

Existing evidence shows that technoference is a widespread phenomenon that affects young children's development. Most research, however, has studied parental distraction by a screen compared to situations when parents are not distracted. While these studies highlight issues regarding screen use during parent-child interactions, it is clear that parents are oftentimes distracted in many other ways during interactions with their child, such as attending to another sibling or finishing cooking a meal. In order to determine the effect of parental distraction from using a screen, it is crucial to provide evidence from experimental conditions when parents are distracted from a similar but non-digital activity. To our knowledge, the empirical evidence on the differential effect of technoference compared to other parental distractions is very scarce. In a U.S. study on question-asking during parent-child interactions, Gaudreau et al. (50) found that only for information-seeking questions of parents—but not of children, nor for responsiveness to questions—distraction from a cell phone showed more negative impact than distraction from a non-digital activity. This finding points to the importance of controlling for parental distraction in order to clarify whether technoference affects parent-child interactions *above and beyond* non-digital parental distractions.

Accordingly, in this study we ask whether technoference affects the interaction and communication skills of parents and young children above and beyond parental distraction from a paper-pen activity. Based on the literature, we made the following hypotheses:

1. Both interaction and communication will be negatively affected when parents are distracted compared to when parents are not being distracted.
2. Both interaction and communication will be negatively affected when parents are being distracted in the screen condition compared to when parents are being distracted in the paper-pen condition, given that digital devices may be especially distracting to parents (23, 51).

Methods

Population

Fifty-two parent-child dyads were invited to participated in this study. Two dyads were excluded because of technical problems preventing from coding the data. The final sample consisted of 50 parent-child dyads; however, interaction scores are missing for one dyad due to disturbances during data collection. The G*Power software indicated that the obtained power for correctly rejecting the null hypothesis (1-β err prob) given an effect size of .25 and the study's sample size is .95.

Mean child age was 22 months (min = 12, max = 36, SD = 7.37 months); 26 girls (52%) participated. Mean parental age was 34 years (min = 27, max = 49, SD = 4.72 years); 45 mothers (90%) participated. Parents were predominantly married or in a couple (88%), mostly highly educated (67% held a university degree) and the large majority had a professional occupation (68%). Participants were recruited in the metropolitan area of a large French-speaking city in Switzerland by posting flyers in day-care centers and pediatric practices, by word-of-mouth, and through advertisement on social networks.

Procedure

Data was collected in a quiet laboratory room over the summer of 2021. Upon arrival of the parent-child dyads, an experimenter explained that the purpose of the study is to evaluate parent-child interaction (without mentioning parental distraction), answered eventual questions and obtained written consent from parents. Each parent-child dyad was invited to sit on a foam tile carpet on the floor; several cushions were supplied. A seek-and-find book as well as a wooden bear puzzle were provided for the interactive play session (see Figure 1). All parent-child interactions were videotaped by a static camera. Before leaving the room, the experimenter reminded participants that the interaction was being filmed and asked them to remain facing the camera.

All dyads were instructed to play for 10 min as they usually would do in a quiet room. Participating dyads were randomly

FIGURE 1
Materials used for the interactive play session.

assigned into one of three condition. In the first condition, parent-child dyads interacted for 10 min without distraction ("control group", 16 dyads, or 32%). In a second condition ("paper-pen distraction", 17 dyads, 34%), each dyad interacted for 5 min without distraction (Time 1), then was interrupted by the experimenter who asked the parent to fill in a demographic questionnaire on paper while continuing to interact with the child for additional 5 min (Time 2); the experimenter then left the room. In the third condition ("screen condition, 16 dyads, 32%), each dyad interacted for 5 min without distraction (Time 1), then was interrupted by the experimenter who asked the parent to fill in a demographic questionnaire on a digital tablet while continuing to interact with the child for additional 5 min (Time 2); the experimenter then left the room.

In all conditions, after ten minutes of interaction, the experimenter returned to the room and stopped the video recording. Parents were then invited to complete the demographic questionnaire either in the lab or at home. Each session lasted approximately 40 min. At the end of each session, participants were informed about the focus of the study on parental distraction and were given the possibility to retract their participation if they no longer agreed with the aims of the study; no participants retracted. All participants received a CHF20 gift voucher for a bookstore.

Measures

Demographic questionnaire

A 13-item demographic questionnaire contained questions about the child (e.g., age, nationality, child's place in siblings and dominant childcare arrangement) and the parent (e.g., age, gender, education and marital status).

Interaction skills

The interaction skills of the child, the parent and of the dyad taken together were assessed during the 10-minute observed play using the Coding Interactive Behavior scheme [CIB (52, 53); for French validation]. This tool codes parent-child interactions across three types of scales: child, parent, and dyad.

The child scale consists of items divided into three composite scores: social involvement, withdrawal/negative emotionality, and compliance; for the purposes of this study, we focus on the social involvement and withdrawal composite scores. The child social involvement composite score is coded on the following 9 items: child gaze/joint attention, positive affect, child affection to parent, alert, fatigue (reversed score), child vocalization/verbal output, child initiation, competent use of environment, and creative symbolic play. The child withdrawal composite score is coded on the following 4 items: negative emotionality/fussy, withdrawal, emotional lability, and child avoidance of parent.

The parent scale type consists of items divided into four composite scores: sensitivity, intrusiveness, limit setting, and negative mood; for the purposes of this study the two former composite scores are used. The parent sensitivity composite score is coded on the following 10 items: acknowledging child's signals, elaborating on child's signals, parent gaze/joint attention, positive affect, vocal appropriateness/clarity, appropriate range of affect, resourcefulness, praising of the child, affectionate touch, and parent supportive presence. The parent intrusiveness composite score is coded on the following 4 items: forcing, overriding child's signals, parent anxiety, and criticizing the child.

The dyad scale consists of items divided into two composite scores. The dyadic reciprocity composite score is coded on the following 3 items: dyadic reciprocity, adaptation-regulation, and fluency. The negative state composite score is coded on the 2 following items: constriction and tension.

Each item is coded on a scale from 1 to 5, as follows: no manifestation of the item's behavior is observed (1), some manifestations are present but not frequent or constant during the interaction (3), manifestations of the item's behavior are frequent and constant throughout the interaction (5). Codes of 2 or 4 can be used to indicate a tendency towards a low (2) or high (4) level. Accordingly, higher scores indicated higher child social involvement, higher parental sensitivity, but also higher child withdrawal, and higher parental intrusiveness.

For the purposes of this study, the 10 min play session was divided into the first 5 min of the interaction (Time 1, no distraction) and the remaining 5 min of interaction (Time 2, no distraction for the control group, paper-pen distraction, or screen distraction). Each time (Time 1 and Time 2) was coded separately.

Coders were trained to use the CIB scheme by a licensed coder who obtained reliability with Ruth Feldman's team. Once coders reached reliability with the licensed coder on a different video dataset, they coded the video data from the present study. A randomly selected 20% of the video data was double-coded; inter-rater agreement was 80%, indicating that both coders gave the same score or a score that differed by maximum one point at the 5-point Likert scale in 80% of the cases.

Communication skills

Verbal communication skills were assessed using the word tokens and word types produced by the child and the parent during the 10 min play interaction. Additionally, non-verbal communication skills were evaluated in children through the gestures they produced during the 10 min interaction.

Word tokens and types scores were based on the transcription of the speech produced by the child and the parent. Speech was transcribed following an adaptation of transcribing conventions from Hoff (54). Transcriptions were analyzed for total number of words produced during the interaction (i.e., word tokens, e.g., "go, go!" counts as two word tokens) and for total number of different words produced during the interaction (i.e., word types; e.g., "go, go!" counts as one word type) using the CLAN software. Word tokens and word types frequencies were extracted for each protagonist, i.e., child and parent. For the purposes of this study, each protagonist received a word tokens and types frequency score for Time 1 and Time 2.

We further coded for children's nonverbal communication skills during the parent-child interaction, following earlier work (55). Gesture was defined as a communicative hand (e.g., pointing at a ball, extending open palm toward a ball) or body

movement (e.g., shaking head sideways to convey negation, extending arms sideways to convey airplane) that was directed to the parent and that did not manipulate objects, such as hammering a peg. All gestures were empty-handed with the exception of show gestures, during which the child brought an object to the parent's attention by holding it up. The frequency of gestures produced by the child was determined for Time 1 and Time 2 of the parent-child interaction session. A randomly selected 20% of the video data was double-coded; inter-rater agreement was 80%.

Data analysis

The dependent variables in our analyses were the following: score for child social involvement during the interaction, score for child withdrawal during the interaction, total number of gestures produced by the child, total number of word tokens produced by the child, total number of word types produced by the child, score for parental sensitivity during the interaction, score for parental intrusiveness during the interaction, total number of word tokens produced by the parent, total number of word types produced by the parent, score for dyadic reciprocity during interaction, and score for dyadic negative states during interaction; all dependent variables showed a non-normal distribution. In order to answer our first research question, namely to determine whether parental distraction—independently of whether it is a paper-pen distraction or a screen distraction—alters parent-child interaction and communication, we performed a Wilcoxon signed-rank on the dependent variables between Time 1 and Time 2 for the paper-pen and screen conditions taken together. In order to determine whether parental distraction from filling out a questionnaire on a *screen* (i.e., technoference) alters parent-child interaction and communication above and beyond parental distraction from filling out a questionnaire on a paper-pen format, we performed a set of Kruskall–Wallis analyses on the dependent variables between the three experimental conditions (no distraction, paper-pen distraction, screen distraction) at Time 2. Last, for the dependent variables that showed significant differences between the three conditions at Time 2, we performed Mann-Whitney tests in order to obtain post-hoc comparisons.

Results

Does parental distraction affect parent-child interaction and communication?

Comparing parent-child interaction and communication between Time 1 (i.e., no distraction) and Time 2 (paper-pen or screen parental distraction) shows that parental distraction matters (see Table 1).

Regarding the quality of the parent-child interaction, our results showed that all of the examined variables, except for parental intrusiveness, differed between Time 1 and 2. Specifically, when parents were asked to fill out a questionnaire at Time 2 (either on a paper-pen or screen format), the quality of the interaction was significantly altered compared to Time 1 when they were only instructed to interact with the child: parents were less sensitive to their children's communicative signals and needs ($z = 4.595$, $p < .001$), children engaged less with the parent ($z = 3.233$, $p < .001$) and also showed more withdrawal behaviors ($z = 2.590$, $p = .01$), and the dyads interacted in less reciprocal ways ($z = 4.962$, $p = .001$), showing more negative states ($z = 4.737$, $p = .001$).

In terms of communication scores, however, results showed that only parental speech changed between Time 1 and Time 2, such that parents talked less to their children—both in terms of word quantity ($z = 3.641$, $p = .001$) and word diversity ($z = 3.079$, $p = .012$)—when they were distracted by filling out the questionnaire (Time 2).

Taken together, the analyses showed that when parents were distracted by filling out the questionnaire—independently on whether it was on a paper-pen or a screen format—the quality of the interaction as well as the child-addressed parental speech deteriorated.

TABLE 1 Descriptive statistics (means; standard deviation scores in parentheses) for the dependent variables across the two assessment times (Time 1, Time 2) for the paper-pen and screen conditions taken together. The last column displays the *p*-values for the difference test between the two times.

		Time 1	Time 2	*p*-value
Interaction	Parental sensitivity	4.46 (.29)	3.76 (.55)	.001***
	Parental intrusiveness	1.44 (.45)	1.41 (.53)	.532
	Child social involvement	3.85 (.42)	3.43 (.52)	.001***
	Child withdrawal	1.28 (.58)	1.51 (.67)	.01**
	Dyadic reciprocity	4.46 (.70)	3.21 (.84)	.001***
	Dyadic negative states	1.34 (.54)	1.98 (.44)	.001***
Communication	Child word tokens	44.53 (37.60)	41.74 (41.63)	.350
	Child word types	21.50 (17.43)	21.06 (18.49)	.610
	Child gestures	9.06 (8.02)	7.63 (6.95)	.299
	Parent word tokens	389.82 (149.02)	278.49 (140.63)	.001***
	Parent word types	152.70 (48.36)	129.83 (48.63)	.012*

*$p \leq 0.05$; **$p \leq 0.01$, ***$p \leq 0.001$.

Does technoference affect parent-child interaction and communication skills?

Having established that parental distraction alters parent-child interaction and communication, we asked whether the nature of the distraction—digital vs. non-digital—matters as well.

Results showed that, in terms of interaction quality, parental sensitivity, $H(2, n = 50) = 17.977$, $p < .001$, child social engagement, $H(2, n = 50) = 6.379$, $p = .041$, and dyadic reciprocity, $H(2, n = 50) = 16.727$, $p < .001$, as well as dyadic negative states, $H(2, n = 50) = 10.567$, $p = .005$, were significantly different across the three experimental conditions at Time 2 (see Table 2). Regarding

TABLE 2 Descriptive statistics (means; standard deviation scores in parentheses) for the dependent variables at Time 2 by condition. The last column displays the *p*-values of the difference test between the three conditions.

		No distraction	Paper-pen distraction	Screen distraction	*p*-value
Interaction	Parental sensitivity	4.46 (.33)	3.77 (.51)	3.77 (.60)	.001***
	Parental intrusiveness	1.56 (.60)	1.35 (.44)	1.51 (.62)	.733
	Child social involvement	3.78 (.27)	3.37 (.60)	3.56 (.35)	.041*
	Child withdrawal	1.28 (.36)	1.37 (.49)	1.67 (.82)	.465
	Dyadic reciprocity	4.38 (.73)	3.28 (.79)	3.29 (.88)	.001***
	Dyadic negative states	1.45 (.53)	2.01 (.39)	1.95 (.52)	.001**
Communication	Child word tokens	50.44 (56.74)	34.94 (29.63)	45.82 (51.03)	.912
	Child word types	26.44 (24.40)	19.35 (16.57)	20.82 (19.52)	.753
	Child gestures	9.63 (8.55)	8.53 (8.04)	7.12 (5.83)	.805
	Parent word tokens	368.75 (116.92)	267.23 (140.02)	287.82 (148.76)	.054†
	Parent word types	148.25 (34.21)	131.06 (50.30)	125.76 (48.29)	.259

†$p \leq 0.1$; *$p \leq 0.05$; **$p \leq 0.01$, ***$p \leq 0.001$.

communication, only parental production of word tokens showed a tendency towards a significance between the conditions, $H(2, n = 51) = 5.838$, $p = .054$. Mann–Whitney comparisons revealed that, for all of the dependent variables that showed significant between-condition differences, the no distraction condition always differed significantly from the paper-pen as well as the screen condition ($p_s \leq .04$). Importantly, for none of the dependent variables, there were significant difference between the paper-pen distraction condition and the screen distraction condition ($p_s \geq .59$). This last result reveals that the nature of the distraction—namely, from a paper-pen or a screen activity—does not matter for the parent-child interaction and communication.

Discussion

In this study we asked whether technoference affects the interaction and the communication between parents and their children during a 10 min play. Observing 50 parent-child dyads, we found that parental distraction matters for the quality of interaction and for the quantity of communicative acts, independently on whether parents were distracted by a paper-pen questionnaire or by a questionnaire on a screen.

Effect of distraction on parent-child interaction and communication

Our first main result shows that when parental focus of attention is shifted from the child to another activity, the quality of interaction is negatively impacted. Specifically, when parents were distracted during the parent-child play, parents were less sensitive to children's communicative signals, children showed lower social involvement, and the dyads showed less reciprocity and more negative states in their exchanges. These findings align with previous theoretical and empirical work highlighting that children, especially young children, need the attention of their parents during moments of interaction and play. When parents pay attention to their children, they acknowledge and respond to the child's behavior and needs, which, in turn, contributes to the child's early social, communicative and emotional development (10).

Importantly, our study suggests that the fact that parents are not focused on the interaction with their child has a negative effect not only on themselves (i.e., parents being less sensitive to the child), but also on the child *and* on the dyad altogether. Precisely, from early on, children are able to detect that the parent is non-contingent and unsynchronized when being distracted, which results in the child being less involved in the interaction with the parent and more withdrawn, as indexed by behaviors such as sharing less joint attention, showing less positive affect, producing less verbal output, initiating less interactions, etc. Unsurprisingly, the parental distraction during the parent-child interaction also negatively affects the interactive quality of the dyad: dyads engage in less give-and-take synchrony, coordinate less levels of arousal and stimulation, show less smooth and fluent flow of activity and involvement and show higher levels of constriction and tension.

Our findings showed that parental distraction also affects the communicative exchanges between the parent and the child during the 10 min play. Specifically, parents produced less word tokens (i.e., measure of verbal quantity) and less word types (i.e., measure of verbal variability) in the conditions when parents were distracted. This result confirms our hypothesis according to which parental distraction negatively influences the communicative bids between the parent and the child. Interestingly, we did not find differences in the verbal or non-verbal communication that children were addressing to parents across the undistracted (Time 1) vs. distracted condition (Time 2). It is possible that when parents were distracted, children continued to produce communicative bids in order to regain the attention of their parent, thus maintaining a similar level of communication. This hypothesis remains to be further examined in future studies.

Lack of effect of technoference on parent-child interaction and communication

Our second main result is that technoference, namely parental distraction due to using a digital device, does not affect parent-

child interaction, nor communication more so than non-digital parental distraction. More specifically, we failed to found a difference between parental distraction due to using a screen compared to parental distraction due to a non-digital activity (i.e., paper-pen condition). This result is in conflict with our hypothesis—we expected that technoference will show a more pronounced negative effect on parent-child interaction quality and communication compared to the non-digital distraction, given that screens are especially distracting to parents (51). Why the lack of effect then?

A first explanation lies within the existing evidence. While the vast majority of studies on technoference point to negative effects, including on parent-child interaction and communication, these studies are either qualitative, thus failing to provide comparisons from experimental conditions, or compare conditions of parents using screens (i.e., technoference) to conditions of parents not using screens [i.e., paying attention to the child; for a review, see (25)]. Therefore, general conclusions about the negative effects of technoference have been drawn, although without examining whether these effects stem specifically from parental distraction *by screens* or simply from parental distraction.

A major strength of the present study is to provide comparisons of parent-child interaction and communication across three experimental conditions: undistracted parents, parents distracted by a non-digital activity (i.e., completing a paper-pen questionnaire) and parents distracted by an activity on a screen (i.e., technoference). Such comparisons suggest that parents are not more distracted by a screen than by another non-digital activity. Recent literature providing evidence from similar comparisons show similar findings. For example, comparing parent-child interactions while parents used a cell phone to parent-child interactions while parents completed a paper survey, Gaudreau et al. (50) did not find a difference in parental, nor child responsiveness. Similarly, while Abels et al. (23) show that when caregivers use mobile media they are less responsive to children's bids for attention, their findings indicate that this appears to also be true when caregivers are involved in other non-child-related activities.

Taken together, our results add to the existing evidence showing that parents do not seem to be more distracted when using a screen compared to other types of distraction. This might be so because screens are so ubiquitous in today's society, that both parents and children have become accustomed to such devices. Stockdale et al. (56) suggests that this could imply a form of self-regulation learning for the child. In the same vein, we can also assume that the parent becomes accustomed to and implements communicative strategies when using a screen during interactions with the child. This assumption could reduce the negative effects on the quality of the interaction.

It is also likely that digital devices prompt a joint attention phenomenon; namely, children could find screens attractive, thus increasing the likelihood of joining in the parent's focus of attention drawn from the screen—possibly more so than when parents are involved in a non-screen activity. There is evidence that when parents and children are co-viewing and especially when parent use this co-viewing as an opportunity for interaction, conversation and sharing (5), children do benefit from such screen use, including for their language development (57).

Limitations

While the present cross-sectional study adds important findings to the existing literature, it also presents a number of limitations. First, the sample represents a limitation in terms of size and representativeness. It includes 50 dyads (considered a high number for observational studies) and is relatively homogeneous in terms of parent gender (vast majority of mothers), parent education (highly educated parents), and marital status (over-representation of married parents/couples). Second, ecological validity is affected by the experimental setting, which is not representative of everyday parent-child interactions in a natural environment. This may result in a motivational bias with regard to participation, with parents in difficulty with their child avoiding taking part in the study. This may also manifest itself as a social desirability bias through the desire to satisfy social expectations in terms of child rearing. Importantly, the type of parental digital distraction in this study (i.e., completing a questionnaire on a tablet) is different in many ways from the real world, everyday ways in which parents use screens in the presence of their children. Specifically, in our study, parental digital distraction did not include the personal or professional context of screen use, neither any emotional aspect in the nature of the digital distractor, such as for example when consulting work emails or responding to personal messages. In such naturalistic situations of screen use, parents are likely more compelled to use screens and presumably they are more absorbed in the screen use and distracted from the interaction with the child.

Last, parental gestures were not coded due to personnel shortage. It would have been interesting to have the coding of parents' gestures in order to better understand certain effects observed in the interaction. In fact, several authors (58–60) have stressed the importance of the synchronicity aspect in the interaction, which implies a mutual influence between one and the other.

Drawing from these limitations, future studies are needed in order to provide better understanding of the effect parental use of screens might or might not have on young children. Importantly, longitudinal studies controlling for a number of significant confounds are truly needed in order to capture possible causal links. These include, but are not limited to, the level of immersion (61) or absorption (25, 30, 57) of the parent during screen use and children's everyday experiences and habits with parental screen use.

Conclusion

This study suggests that technoference does disrupt parent-child interaction, but in similar ways than an equivalent non-digital parental distraction. The finding adds to the extensive

literature on the importance of parental involvement for the quality of the parent-child interaction. It also allows to dedramatize a certain "moral panic" (62) surrounding screen use. More specifically, it suggests that it might not the use of the screen itself that is derogatory for the interaction; rather, it could the fact that the parent is kept away from the interaction, independently from whether it is a digital or a non-digital distraction.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Commission interdisciplinaire d'Ethique de la Faculté des sciences sociales et politiques de l'Université de Lausanne (E_SSP_042021_00002). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

SC: Formal Analysis, Investigation, Methodology, Writing – original draft. AF: Formal Analysis, Investigation, Methodology, Writing – original draft. NM: Formal Analysis, Investigation, Methodology, Writing – original draft. FQ: Formal Analysis, Investigation, Methodology, Writing – original draft. ND: Formal Analysis, Investigation, Methodology, Writing – original draft, Conceptualization, Funding acquisition, Project administration, Resources, Supervision.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Cure for tantrums? Longitudinal associations between parental digital emotion regulation and children's self-regulatory skills

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Introduction: Parents often use digital devices to regulate their children's negative emotions, e.g., to stop tantrums. However, this could hinder child development of self-regulatory skills. The objective of the study was to observe bidirectional longitudinal associations between parents' reliance on digital devices to regulate their child's emotions and self-regulatory tendencies (anger/frustration management, effortful control, impulsivity).
Methods: Parents ($N = 265$) filled out the Child Behavior Questionnaire—Short Form and the Media Assessment Questionnaire twice: the initial assessment (T1) took place in 2020 (mean child age = 3.5 years old), and follow-up (T2) occurred a year later in 2021 (mean child age = 4.5 years old).
Results: Higher occurrence of parental digital emotion regulation (PDER) in T1 predicts higher anger and lower effortful control in T2, but not impulsivity. Higher anger in T1, but not impulsivity and effortful control, predicts higher PDER in T2.
Discussion: Our results suggest that parents of children with greater temperament-based anger use digital devices to regulate the child's emotions (e.g., anger). However, this strategy hinders development of self-regulatory skills, leading to poorer effortful control and anger management in the child.

KEYWORDS

emotion regulation, self-regulation, digital devices, longitudinal, effortful control, impulsivity

1 Introduction

Digital device use among young children is markedly increasing. Children are introduced to screens at earlier and earlier developmental stages (1). Screen-based activities occupy the largest part of children's free time, compared to outdoor play or other screen-free activities (2). Pre-pandemic studies report that preschoolers spend about 1.5–2.5 h in front of a screen daily (3, 4), and this amount has increased by one hour during the pandemic (5). The proportion of families that possess mobile devices has increased from 52% in 2011 to 98% in 2020 and almost half of 2- to 4-years-olds have their own mobile device (6). About 26% of children aged 0–4 from the United States spend more than 4 h in front of a screen daily, meaning a two-fold increase compared to 13% before the pandemic (7). Despite these tendencies the effects of

screen time on child emotional and cognitive development are still debated and largely unknown (8). The widespread usage of electronic media and digital devices (TV, videogames, PC, smartphones, tablets, etc.) may influence even adults' cognition, emotions, and mental health (9, 10). However, young children's brain and cognitive processes are still plastic, making them even more potentially vulnerable to strong and long-lasting influences of experiences (11–13).

Early childhood is a critical time for learning basic self-regulation skills (14). Self-regulation is conceptualized as the organization or modulation of affective, mental, and behavioral responses, including control over emotional experiences and expressions (i.e., emotion regulation), cognitive processes (i.e., executive function), and approach or withdrawal behaviors (i.e., effortful control) (15). Executive function and effortful control are related and, according to some researchers, overlapping constructs (16, 17). Effortful control has been defined as children's ability to inhibit a dominant response in favor of a subdominant one, or an automatic response in favor of a deliberate one (18, 19). It involves the management of attention or behavior. Effortful control is temperamentally based, but also develops with considerable input from the environment (19) especially through children's early social relationships with their parents (20, 21).

Emotion regulation involves implicit or explicit attempts to modify the natural trajectory of one or more parameters of emotion (22), including physiological arousal, expression, intensity or duration. It is related to temperamental emotional reactivity [high reactivity hinders its effectiveness (23);], and to coping [i.e., the ability to cope with the stressful situation (24, 25)]. Emotion regulation emerges in rudimentary forms in infancy (26), and gradually progresses from being a highly external process to an internal one over time (25). Certain early childhood experiences, e.g., appropriate family interactions are necessary for this developmental process (27).

In the past decades, digital devices have become increasingly prevalent in people's lives and became objects with which emotions, cognition, and behavior can be regulated. Therefore, devices and screen-based activities have become external tools of self-regulation. For example, digital activities (e.g., videogaming, watching videos, instant messaging) often serve an emotion-regulating purpose in adults ["digital emotion regulation"; (28); for a review: (29)]. They help in coping with or recovery from negative emotions and stress by providing a sense of mastery and control (29, 30), an immersive or "flow" experience (31–33), and by providing a distraction from real-life problems or escape from reality into the virtual world (34). Digital activities offer instant rewards (35, 36) which can modulate one's mood and emotions. Digital activities can also help in arousal-regulation for individuals with lower arousal by offering stimulation through e.g., fast-paced, intensive, simultaneous stimuli (8, 37) or arousing (e.g., violent) contents, which activate the dopamine and the reward pathways (8).

Parents often give digital devices to their child to "safely" engage them ("baby-sitter" function), and to regulate their emotions or behavior (38–40). Kabali et al. (41) found that 65% of parents use mobile devices to keep their child calm in public places. Television is also commonly used as a calming tool for children (42, 43). We refer to this phenomenon as parental digital emotion regulation (PDER), designating parental behaviors such as giving the child a digital device to regulate their negative emotions or calm them down.

Providing children with digital devices as "digital pacifiers" (41) may reduce child emotional expressions in the short term and may help parents allocate resources to necessary tasks and provide them with free time, especially during lockdown (44). However, this practice may also lead to missed opportunities to teach adaptive emotion regulation and coping strategies to the child (45). Although the distraction of attention away from stressful stimuli or negative emotions can be an effective short-term strategy to reduce emotional intensity in young children (46), suppressing emotions can have paradoxical, rebounding effects [e.g., (47)], and it may lead to maladaptive, avoidant coping strategies, increased negative emotionality or dysregulation in the future. Additionally, for children with immature self-regulatory skills, it may be harmful to become accustomed to external devices to regulate their emotions, as this could interfere with the development of internal regulatory mechanisms. Dependence on the device may lead to problematic media use and "screen time tantrums" (48), i.e., extreme emotions when media is removed (40). In addition, when digital devices are used for getting instant rewards (35, 36), it may hinder one's ability to delay gratification and control impulses (49, 50). This may lead to a positive feedback loop. As a consequence, an association is frequently found between media use and impulsivity (51–53) or poorer executive functions (54–57).

Empirical evidence suggests a negative association between digital media use and self-regulation. For example, more time spent watching TV was associated with higher ratings on negative emotionality, emotional reactivity, aggression, and attention problems, as well as lower levels of soothability in toddlers (58). Children who began using screen media devices earlier or who spent more time engaging with mobile devices displayed lower self-regulation (59). Longitudinal data mainly suggest bidirectional relationships. For example, screen time or digital media use at a younger age was negatively associated with later child self-regulation or related processes, such as executive function and effortful control (37, 55, 57, 60–62). However, findings also support the reverse association: emotion dysregulation and poor self-regulation was found to contribute to greater and more problematic media use later (37, 42, 63, 64). However, whether bidirectional associations exist between the use of PDER and child self-regulation remains unknown.

The few studies investigating PDER suggest its potential role in child self-regulatory skills development. Coyne et al. (40) found that temperamental dysregulation risk factors, specifically negative affectivity and surgency (65, 66), were related to problematic media use and screen time tantrums through PDER. This suggests that difficult temperament (entailing low self-regulation skills) leads to PDER, which, in turn, leads to problematic media use. In line with this, children with social-emotional difficulties, poor self-regulation and a difficult temperament have a higher

chance of being given digital technology as a calming tool or as a baby-sitter (39, 42, 43, 67, 68) and perhaps as a result, they use more media later (37, 62, 64, 69).

However, as far as we know, only one longitudinal study (69) investigated the bidirectional associations between PDER and child self-regulation. This study found an interaction effect: PDER in an earlier time point (T1) was positively related to increases in children's negative emotionality in a later time point (T2), but only for children with initially low negative emotionality. Further longitudinal studies are needed as the above-mentioned results are not in line with the frequently found bidirectional association between media use and self-regulation. Therefore, the objective of the study was to observe bidirectional longitudinal associations between PDER and child self-regulatory tendencies (anger/frustration management, effortful control, impulsivity). Since self-regulatory skills are still immature in the preschool age, PDER can have a great impact on them. Therefore, we aimed to investigate this age group. We also accounted for the confounding effects of parenting stress, child screen time, and family sociodemographics.

This is a confirmatory study with clear hypotheses: we expect that poorer child self-regulatory tendencies (i.e., higher level of anger/frustration management problems, impulsivity and lower level of effortful control) (at T1) lead to higher PDER (at T2), and that higher PDER (at T1) leads to poorer child self-regulatory tendencies (higher anger/frustration management problems and impulsivity, and lower level of effortful control) (at T2).

2 Materials and method

2.1 Procedure and participants

This study is part of a larger, two-year longitudinal study on digital media use by Canadian families with preschool children aged 2–5 years during the COVID-19 pandemic. Participating families were recruited using eye-catching posters and flyers in preschools and pre-kindergarten classes, sign-up sheets and presentations given at preschool and pre-kindergarten registration nights, a Facebook page, and newspaper and radio advertisements broadcast across Nova Scotia (Canada). To measure bidirectional associations between parental digital emotion regulation and child self-regulation tendencies, we measured these variables at two time points.

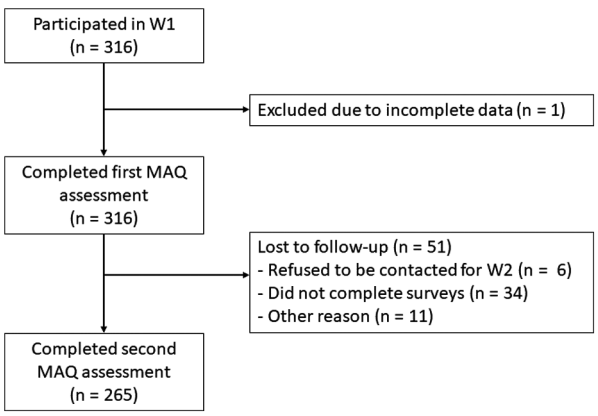

FIGURE 1
Flow diagram showing the number of participants contacted, lost for specific reasons and retained.

The first assessment took place between March and August of 2020 ($N = 316$ children), during a provincially declared state of emergency and lockdown. A follow-up with this sample was conducted a year later, between April and August of 2021 ($N = 265$; a flow diagram of the participants is presented in Figure 1). Demographics for the retested sample are presented in Table 1.

At both time waves, parents completed the web-based Media Assessment Questionnaire (MAQ), which has been described in detail elsewhere (70). The MAQ assesses child and parent media use and includes questions on child age and sex, parent education, as well as reasons reported by parents to allow their child to use media. For the purpose of this study, we integrated items on child temperamental anger/frustration, impulsivity and effortful control using the Child Behavior Questionnaire—Short Form (71). We also integrated items on parenting stress using the Parenting Stress Index (72). These measures are described below. The use of data for this specific study received approval from the ethics board from the principal investigator's institution (IRB #2021-2927). Informed consent to participate was obtained from participating parents.

2.2 Measures

2.2.1 Parental digital emotion regulation (PDER)

Parents were asked to rate how much they agreed or disagreed with the statement "I let my child use media to calm them down when they are upset". Responses were rated on a 7-point Likert scale ranging from *Never* (1) to *Several times per day* (7). Due to some of the response options having very small frequencies (e.g., "Several times per day": $N = 4$), this variable was then recoded into a dichotomous variable (1 = Never/rarely, 2 = Regularly/frequently; see Table 1 for descriptives).

2.2.2 Child self-regulatory tendencies

The Child Behavior Questionnaire—Short form (71) assesses several distinct dimensions of temperament which are grouped into three main factors: negative affectivity, surgency/extraversion, and effortful control. The short form shows satisfactory internal consistency, criterion validity, longitudinal stability and inter-rater agreement (71, 73). Since we focus on temperament-based self-regulatory tendencies, we retained for this study (1) anger/frustration ("anger" hereinafter) which is a dimension belonging to the negative affectivity main factor, (2) impulsivity which is a dimension belonging to the surgency/extraversion main factor, and finally (3) the main factor of effortful control. Anger (e.g., "Child gets angry when told s/he has to go to bed") and impulsivity (e.g., "Usually rushes into an activity without thinking about it") were each based on the mean

TABLE 1 Descriptive statistics of the final sample ($N = 265$).

Variable	Measure	*N* (%)	M ± SD (Min, Max)
Child age T1	In years	*N* (%) missing = 1 (0.4)	3.46 ± 0.84 (2, 5.42)
Child age T2	In years	*N* (%) missing = 0	4.33 ± 0.86 (2.75, 6.33)
Child sex	(2 values)	*N* (%) boys = 138 (52.1) *N* (%) girls = 126 (47.5) *N* (%) missing = 1 (0.4)	
Parent age T1	In years	*N* (%) missing = 0 (0)	35.24 ± 4.28 (23, 52)
Parent age T2	In years	*N* (%) missing = 0 (0)	36.24 ± 4.28 (24, 53)
Parent sex	(2 values)	*N* (%) males = 20 (7.5) *N* (%) females = 245 (92.5) *N* (%) missing = 0 (0)	
Parental education	(3 values)	*N* (%) college or secondary degree = 62 (23.4)	
		N (%) bachelor's degree = 129 (48.7)	
		N (%) master or doctoral degree = 74 (27.9) *N* (%) missing = 0 (0)	
Yearly income	(3 values)	*N* (%) $59,999 and less = 40 (15.1)	
		N (%) 60,000–$99,999 = 72 (27.2)	
		N (%) $100,000 and more = 136 (51.3) *N* (%) missing = 17 (6.4)	
Race	(7 values)	*N* (%) Aboriginal = 2 (0.8) *N* (%) Asian = 5 (1.9) *N* (%) Black = 2 (0.8) *N* (%) White = 242 (91.3) *N*% Don't know = 0 (0) *N* (%) Prefer not to answer = 1 (0.4) *N* (%) Other = 12 (4.5) *N* (%) missing = 1 (0.4)	
Country of birth	(2 values)	*N* (%) Canada (country) = 239 (90.2) *N* (%) Other = 25 (9.4) *N* (%) missing = 1 (0.4)	
Marital status	(6 values)	*N* (%) Married = 218 (82.3) *N* (%) Single/Never married = 11 (4.2) *N* (%) Live-in partner = 28 (10.6) *N* (%) Divorced = 2 (0.8) *N* (%) Widowed = 0 (0) *N* (%) Separated = 5 (1.) *N* (%) missing = 1 (0.4)	
Child screen time T1	In hours/day	*N* (%) missing = 0 (0)	3.45 ± 2.45 (0, 10.43)
Child screen time T2	In hours/day	*N* (%) missing = 0 (0)	3.26 ± 2.38 (0, 9.65)
Parenting stress T1	(total score 0–5)	*N* (%) missing = 0 (0)	1.85 ± 0.53 (1, 3.76)
Parenting stress T2	(total score 0–5)	*N* (%) missing = 0 (0)	1.14 ± 0.72 (0, 3.11)
CBQ anger T1	(total score 0–7)	*N* (%) missing = 0 (0)	4.25 ± 1.11 (1, 7)
CBQ anger T2	(total score 0–7)	*N* (%) missing = 0 (0)	4.26 ± 1.15 (1, 6.67)
CBQ impulsivity T1	(total score 0–7)	*N* (%) missing = 0 (0)	4.43 ± 0.93 (1.67, 7)
CBQ impulsivity T2	(total score 0–7)	*N* (%) missing = 0 (0)	4.19 ± 0.94 (1.33, 6.83)
CBQ effortful control T1	(total score 0–7)	*N* (%) missing = 0 (0)	4.71 ± 0.82 (2.58, 6.83)
CBQ effortful control T2	(total score 0–7)	*N* (%) missing = 0 (0)	4.88 ± 0.82 (2.75, 7)
Parental digital emotion regulation T1	(after merging: 2 values)	*N* (%) never/rarely = 165 (62.3) *N* (%) regularly/frequently = 100 (37.7) *N* (%) missing = 0 (0)	
Parental digital emotion regulation T2	(after merging: 2 values)	*N* (%) never/rarely = 179 (67.5) *N* (%) regularly/frequently = 86 (32.5) *N* (%) missing = 0 (0)	

of 6 items. Higher scores in anger and impulsivity subscales indicate greater intensity and duration of the child's angry or frustrated response to environmental stimuli or greater speed of response initiation, respectively. The effortful control factor was based on mean scores obtained for the dimensions of attentional focusing (six items, e.g., "When drawing or coloring a book, shows strong concentration") and inhibitory control (six items, e.g., "Can wait before entering into new activities if s/he is asked to"). Higher scores in the attentional focusing and the inhibitory control subscales indicate better child effortful control. Items are scored on a 7-point Likert scale ranging from 1 (extremely untrue of your child) to 7 (extremely true of your child). The Cronbach's alpha coefficients for anger, impulsivity, and effortful control in Wave 1 were $\alpha = 0.789$; 0.629 and 0.792, respectively. In Wave 2, the corresponding coefficients were $\alpha = 0.814$; 0.656 and 0.785, respectively (see Table 1 for descriptives).

2.2.3 Demographics, parenting stress and child screen time

When completing the MAQ (70), parents reported child age and sex (assigned at birth), parent age and sex, parent education, yearly income, race, country of birth, marital status, and parenting stress. Race, country of birth and marital status were not used in the analyses because there was little variance on these variables (see Table 1 for response options and number/percentage of participants answering them). Parenting stress was assessed using the Parenting Stress Index (72). This questionnaire includes a Parental distress (PD) subscale (12 items, i.e., "I find myself giving up more of my life to meet my child's needs than I ever expected") and a Parent-child dysfunctional interaction (PCDI) subscale (12 items, i.e., "My child smiles at me much less than I expected"). Items were rated on a 5-point Likert scale as: 1 (strongly disagree); 2 (disagree); 3 (not sure); 4 (agree) or 5 (strongly agree) and were then averaged to create a total score ranging from 1 to 5, with an adequate internal consistency (Cronbach's alpha = 0.850). Higher scores indicate higher parenting stress (see Table 1 for descriptives).

In the MAQ, parents also reported their child screen time by reporting the average amount of time their child spent doing each of the following activities: (1) Watching TV or DVDs; (2) Using a computer; (3) Playing video games on a console; (4); Using an iPad, tablet, LeapPad, iTouch, or similar mobile device (excluding smartphones); or (5) Using a smartphone. For each activity, response options were: (1) Never; (2) Less than 30 min; (3) 30 min to 1 h; (4) 1–2 h; (5) 2–3 h; (6) 3–4 h; (7) 4–5 h; and (7) more than 5 h. Parents reported this separately for a typical weekday and a typical weekend day. Total amount of child screen time was calculated by summing the durations for each

activity, using responses' mid-points with the exception of "Never" and "more than 5 h" where scores of 0 and 5 were used, respectively. To compute child average daily screen time, we computed a weighted average of screen time across the week as follows: [(weekday screen time X 5) + (weekend screen time X 2)]/7 (see Table 1 for descriptives).

2.3 Data analytic strategy

First, we compared whether retained (those who participated at T2) and unretained (those who had dropped out) participants were different in any aspects of demographics, parental digital emotion regulation (PDER), or child self-regulation scores (Mann–Whitney tests, *t*-tests and χ^2 tests, using SPSS 28.0.0.0).

Of the final retained sample of 265, 17 participants had a missing value on income and one participant had a missing value for child anger, impulsivity, and effortful control at T2. We performed Little's test to determine if data were missing completely at random (MCAR). The test was not significant revealing that data could be assumed to be MCAR: $\chi^2 = 24.476$, DF = 26, $p = 0.549$.

We imputed missing values on income to the median (value of 3) and used FIML (maximum likelihood information) to account for missing outcome data.

To test bidirectional associations between PDER and self-regulation scales, we estimated cross-lagged panel models using Mplus version 8.10 (74). We controlled for sociodemographic variables such as child age and sex, parent age and sex, parent education, yearly income, child screen time and parenting stress (the model schema is presented on Figure 2).

3 Results

3.1 Comparing retained and unretained participants

Unretained participants were significantly different from retained participants in parents' age (M ± SD = 33.32 ± 4.631 (unretained) vs. 35.226 ± 4.278 years (retained); $t = 2.852$; $p = 0.005$; Cohen's $d = 0.436$) and marginally in PDER (52% vs. 37.6% of regular/frequent PDER in unretained and retained sample, respectively; $\chi^2 = 3.643$; $p = 0.056$; this is discussed in the limitation section), but was not significantly different on any other demographic variables or child behavior variables (all $p > 0.170$).

3.2 Cross-lagged panel model: anger

Our final model is presented in Figure 3. Our cross-lagged panel model provided good fit [CFI = 1.000; TLI = 1.000; RMSEA = 0.000 (0.000; 0.138)] and accounted for 36.7% and 45.8% of the variance in PDER and Anger at T2, respectively. Analyses revealed considerable stability in PDER ($b = 1.233$; SE = 0.187; $p < 0.001$; $\beta = 0.476$) and Anger ($b = 0.567$; SE = 0.054; $p < 0.001$; $\beta = 0.546$) between T1 and T2. In terms of the cross-lagged associations, T1 PDER significantly contributed to higher Anger at T2 ($b = 0.304$; SE = 0.122; $p = 0.013$; $\beta = 0.128$), whereas T1 Anger only tendentiously contributed to higher PDER at T2 ($b = 0.180$; SE = 0.108; $p = 0.094$; $\beta = 0.159$). Parenting stress ($b = 0.018$; SE = 0.007; $p = 0.008$; $\beta = 0.124$) and child screen time ($b = 0.063$; SE = 0.024; $p = 0.009$; $\beta = 0.133$) at T1 were also significantly positively associated with Anger at T2 (Table 2).

3.3 Cross-lagged panel model: impulsivity

Our model is presented in Figure 4. Our cross-lagged panel model provided good fit [CFI = 1.000; TLI = 1.000; RMSEA = 0.000 (0.000; 0.078)] and accounted for 34.7% and 47.8% of the variance in PDER and Impulsivity at T2, respectively. Analyses revealed considerable stability in Impulsivity ($b = 0.670$; SE = 0.051; $p < 0.001$; $\beta = 0.659$) between T1 and T2. In terms of the cross-lagged associations, neither T1 PDER was associated with T2 Impulsivity ($b = -0.064$; SE = 0.094; $p = 0.496$; $\beta = -0.033$), nor T1 Impulsivity with T2 PDER ($b = 0.019$; SE = 0.096; $p = 0.845$; $\beta = 0.014$). Child age was significantly negatively associated with Impulsivity at T2 ($b = -0.126$; SE = 0.057; $p = 0.028$; $\beta = -0.112$; Table 3).

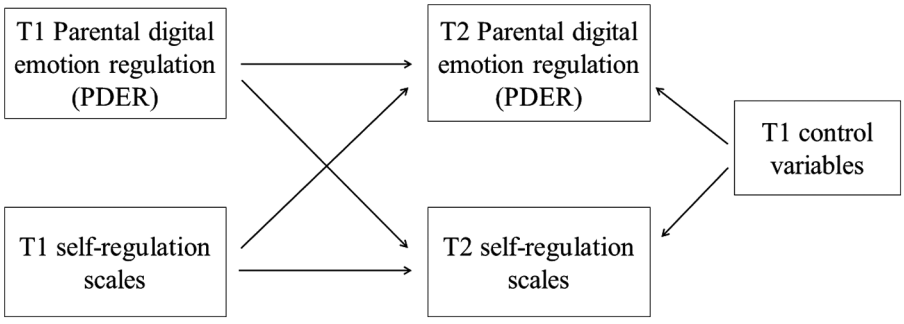

FIGURE 2
Summary of the cross-lagged panel analyses.

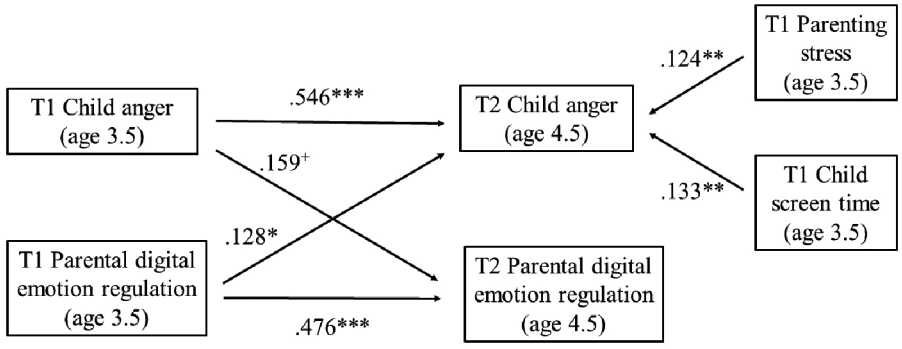

FIGURE 3
Longitudinal cross-lagged associations between parental digital emotion regulation and the anger/frustration dimension of the child behavior questionnaire.

TABLE 2 Results of the cross-lagged panel model measuring the bi-directional associations between PDER (parental digital emotion regulation) and the anger/frustration dimension of the child behavior questionnaire.

	Estimate (b)	se	*p*-value	Beta
Child age → T2 PDER	−0.168	0.118	0.155	−0.112
Child sex → T2 PDER	−0.064	0.190	0.737	−0.025
T1 screen time → T2 PDER	0.054	0.043	0.209	0.105
Parent age → T2 PDER	−0.022	0.025	0.359	−0.077
Parent sex → T2 PDER	0.018	0.382	0.962	0.004
Parent education → T2 PDER	0.127	0.146	0.384	0.073
Yearly income → T2 PDER	−0.048	0.124	0.700	−0.028
T1 parenting stress → T2 PDER	−0.002	0.013	0.870	−0.013
T1 PDER → T2 PDER	1.233	0.187	0.000	0.476
T1 Anger → T2 PDER	0.180	0.108	0.094	0.159
Child age → T2 Anger	−0.021	0.072	0.768	−0.015
Child sex → T2 Anger	−0.066	0.113	0.558	−0.029
T1 screen time → T2 Anger	0.063	0.024	0.009	0.133
Parent age → T2 Anger	0.020	0.014	0.153	0.073
Parent sex → T2 Anger	−0.314	0.178	0.078	−0.072
Parent education → T2 Anger	0.066	0.082	0.425	0.041
Yearly income → T2 Anger	0.036	0.081	0.658	0.023
T1 parenting stress → T2 Anger	0.018	0.007	0.008	0.124
T1 anger → T2 Anger	0.567	0.054	0.000	0.546
T1 PDER → T2 Anger	0.304	0.122	0.013	0.128

3.4 Cross-lagged panel model: effortful control

Our model is presented in Figure 5. Our cross-lagged panel model provided good fit [CFI = 1.000; TLI = 1.000; RMSEA = 0.000 (0.000; 0.000)] and accounted for 34.7% and 55.5% of the variance in PDER and Effortful control at T2, respectively. Analyses revealed considerable stability in Effortful control between T1 and T2 ($b = 0.716$; SE = 0.050; $p < 0.001$; $\beta = 0.718$). In terms of the cross-lagged associations, T1 PDER significantly contributed to lower Effortful control at T2 ($b = -0.182$; SE = 0.075; $p = 0.016$; $\beta = -0.108$), whereas T1 Effortful control did not contribute to higher PDER at T2 ($b = -0.002$; SE = 0.129; $p = 0.986$; $\beta = -0.001$). Parent age was also significantly negatively associated with Effortful control at T2 ($b = -0.019$; SE = 0.008; $p = 0.022$; $\beta = -0.098$; Table 4).

4 Discussion

We investigated the relationships between parental digital emotion regulation and self-regulation in children. Our study revealed complex, bidirectional longitudinal associations between

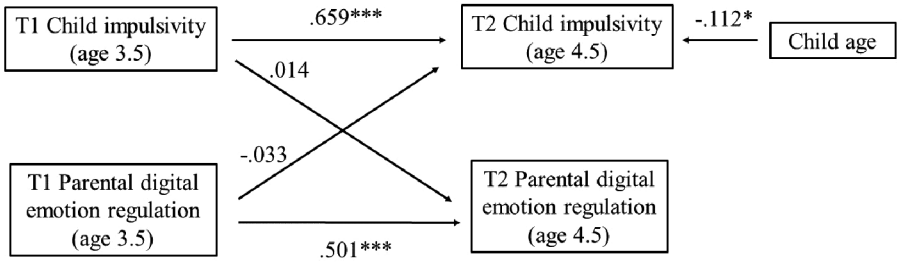

FIGURE 4
Longitudinal cross-lagged associations between parental digital emotion regulation and the impulsivity dimension of the child behavior questionnaire.

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TABLE 3 Results of the cross-lagged panel model measuring the bi-directional associations between PDER (parental digital emotion regulation) and the impulsivity dimension of the child behavior questionnaire.

	Estimate (b)	se	*p*-value	Beta
Child age → T2 PDER	−0.167	0.118	0.158	−0.114
Child sex → T2 PDER	−0.059	0.189	0.755	−0.024
T1 Screen time → T2 PDER	0.064	0.043	0.138	0.127
Parent age → T2 PDER	−0.025	0.025	0.304	−0.087
Parent sex → T2 PDER	−0.007	0.395	0.986	−0.001
Parent education → T2 PDER	0.117	0.145	0.422	0.068
Yearly income → T2 PDER	−0.037	0.121	0.761	−0.022
T1 parenting stress → T2 PDER	0.006	0.012	0.597	0.039
T1 PDER → T2 PDER	1.276	0.185	0.000	0.501
T1 Impulsivity → T2 PDER	0.019	0.096	0.845	0.014
Child age → T2 Impulsivity	−0.126	0.057	0.028	−0.112
Child sex → T2 Impulsivity	−0.122	0.087	0.160	−0.065
T1 screen time → T2 Impulsivity	0.022	0.021	0.297	0.057
Parent age → T2 Impulsivity	−0.004	0.012	0.761	−0.016
Parent sex → T2 Impulsivity	0.203	0.145	0.164	0.057
Parent education → T2 Impulsivity	0.103	0.064	0.106	0.079
Yearly income → T2 Impulsivity	−0.083	0.066	0.207	−0.065
T1 parenting stress → T2 Impulsivity	−0.004	0.005	0.491	−0.031
T1 Impulsivity → T2 Impulsivity	0.670	0.051	0.000	0.659
T1 PDER → T2 Impulsivity	−0.064	0.094	0.496	−0.033

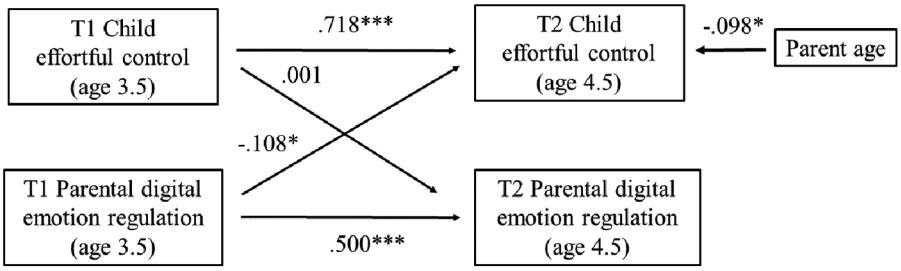

FIGURE 5
Longitudinal cross-lagged associations between parental digital emotion regulation and the effortful control main factor of the child behavior questionnaire.

the investigated variables. The results suggest that parental digital emotion regulation may contribute to the bidirectional association between media use and self-regulation in children (37, 55, 62, 63). The observed associations were consistent and strong in one direction (higher frequency of parental digital emotion regulation leading to higher anger/frustration and lower effortful control), but less consistent and more tendentious in the other direction (effortful control does not, while anger/frustration tendentiously contribute to higher PDER).

4.1 Higher PDER leads to poorer anger/frustration management and effortful control

Higher baseline occurrence of parental digital emotion regulation (PDER) and higher baseline screen time predicted poorer anger/frustration management (i.e., higher anger) one year later. This is in line with findings of a cross-sectional study (hence limitations regarding causal inferences) that more time spent watching TV is associated with higher levels of negative emotionality, emotional reactivity, and aggression, as well as lower levels of soothability in toddlers (58). Longitudinal studies (57, 62) found that baseline digital media use predicted more externalizing problems (specifically, conduct problems and hyperactivity) at follow-up, and these problems often entail difficulties with anger management (75–78). While these associations or effects can be driven by several mechanisms [e.g., direct effects, like overstimulation, and indirect effects, like displacement of social interactions (79)], the present study suggests that using digital devices for emotion regulation might be a key determinant in the development of child difficulties with various aspects of self-regulation. Our results somewhat contradict those of Gordon-Hacker & Gueron-Sela (69), who found in a path analysis that early maternal digital emotion regulation preceded later negative emotionality only in children

TABLE 4 Results of the cross-lagged panel model measuring the bi-directional associations between PDER (parental digital emotion regulation) and the effortful control main factor of the child behavior questionnaire.

	Estimate (b)	se	*p*-value	Beta
Child age → T2 PDER	−0.168	0.120	0.160	−0.115
Child sex → T2 PDER	−0.061	0.189	0.749	−0.024
T1 Screen time → T2 PDER	0.066	0.042	0.118	0.130
Parent age → T2 PDER	−0.025	0.025	0.303	−0.088
Parent sex → T2 PDER	−0.008	0.395	0.983	−0.002
Parent education → T2 PDER	0.117	0.146	0.423	0.068
Yearly income → T2 PDER	−0.039	0.120	0.749	−0.023
T1 parenting stress → T2 PDER	0.006	0.012	0.618	0.038
T1 PDER → T2 PDER	1.275	0.186	0.000	0.500
T1 effortful control → T2 PDER	−0.002	0.129	0.986	−0.001
Child age → T2 Effortful control	−0.066	0.048	0.164	−0.068
Child sex → T2 Effortful control	0.091	0.071	0.202	0.055
T1 screen time → T2 Effortful control	−0.015	0.016	0.349	−0.044
Parent age → T2 Effortful control	−0.019	0.008	0.022	−0.098
Parent sex → T2 Effortful control	−0.108	0.139	0.437	−0.035
Parent education → T2 Effortful control	0.013	0.049	0.788	0.012
Yearly income → T2 Effortful control	0.039	0.048	0.418	0.035
T1 parenting stress → T2 Effortful control	0.005	0.006	0.383	0.046
T1 effortful control → T2 Effortful control	0.716	0.050	0.000	0.718
T1 PDER → T2 Effortful control	−0.182	0.075	0.016	−0.108

with low initial negative emotionality. However, it should be noted that the authors found a significant, although weak ($r = 0.2$) longitudinal correlation between T1 maternal digital emotion regulation and T2 negative emotionality, and a slightly stronger cross-sectional correlation ($r = 0.37$) between T2 maternal digital emotion regulation and T2 negative emotionality, but neither of them were significant in the path analysis. One possible explanation for the divergent findings in their study and ours, is the different age groups of the children. Additional explanation for these somewhat contradictory results should be revealed through further longitudinal studies. Furthermore, screen time and PDER are closely related, and as the present design does not allow for the separation of the two phenomena, further research is needed to disentangle their respective effects on child self-regulation.

Higher occurrence of PDER at T1 also predicted lower levels of effortful control at T2. In line with this, longitudinal studies have found that those who spend more time using digital devices subsequently develop more attentional problems, impulsivity, and poorer executive functions or self-regulation in general (37, 55, 61, 64, 80). These results corroborate the involvement of PDER in developing self-regulation problems. Contrary to our expectations, however, PDER in T1 did not predict impulsivity in T2. This contrasts with the findings of several studies which showed that digital device use leads to hyperactivity, inattention or externalizing behaviors (81). It was also unexpected that T1 PDER predicted only effortful control, whereas impulsivity and effortful control are related constructs (16, 17). The scale of effortful control is made up of items on attentional focusing (e.g., Tendency to maintain attentional focus upon task-related channels) and inhibitory control (e.g., The capacity to plan and to suppress inappropriate approach responses under instructions or in novel or uncertain situations). On the other hand, impulsivity is defined as the "speed of response initiation" (71), consisting of items like "Usually rushes into an activity without thinking about it". While high impulsivity entails low inhibitory control, and both are related to behavioral self-regulation, attentional focusing is a different, more cognitive construct and does not necessarily correlate with the other two (82, 83). It is possible that PDER affects attentional processes inherent to effortful control to a larger extent than behavioral self-regulation. Higher PDER is associated with higher screen time (38) and the latter may have negative effects on attentional focusing (37, 80), for example, as a result of overstimulation (84). The associations between early digital media use and later attentional problems are well supported by empirical data (37, 80), while relationships between digital media use and executive functions are more contradictory (54, 56, 61, 85–87). Therefore, further studies should investigate the longitudinal associations of PDER with attentional focusing and inhibitory control separately.

4.2 Poorer anger/frustration management skills in T1, but not impulsivity and effortful control, predicts tendentiously higher occurrence of parental digital emotion regulation in T2

Poorer baseline anger/frustration management skills (i.e., higher anger) tendentiously predicted higher occurrence of PDER at follow-up. This result is in line with cross-sectional findings showing that children with social-emotional difficulties, poor self-regulation and a more difficult temperament have a higher chance of being given digital technology as a calming tool or as a baby-sitter (39, 43, 67, 68) and with longitudinal studies showing that these problems lead to using more media later (37, 42,

62, 64). Our study is the first longitudinal study in support of poor emotion regulation leading to higher chances of parental digital emotion regulation, although the association was only marginally significant ($p = 0.094$). Parents with difficult children may struggle more with decreasing the tempers or negative emotions of the child. Therefore, they may turn to digital devices to alleviate their burden. As Radesky et al. (39) pointed out, "frustration with the child's behavior would lead to use of digital media as a coping strategy" (p. 397). Similarly, instrumental use of media (using media as a behavior modifier or as a babysitter) was primarily endorsed by parents who are less confident about their parenting (68), and children with difficult temperament may contribute to parents being less confident about their parenting skills (88, 89).

Impulsivity and effortful control did not predict later PDER. This suggests that parents use digital media as a parenting tool only for managing emotional self-regulation problems in the child, but not cognitive or behavioral self-regulation problems. This result is unexpected, but may reflect the fact that impulsivity and lower effortful control in the child may be less challenging for the parent than anger management problems, as the latter entails emotional outburst and tantrums. Some studies (67, 68) indicate that impulsivity and lower effortful control (specifically, conduct problems and energetic temperaments) are associated with PDER. However these studies are cross-sectional and cannot inform causal nor directional inferences. The present longitudinal study suggests that these self-regulatory tendencies do not lead to PDER, but rather the other way around as we found that PDER led to lower effortful control. Although many longitudinal studies found that children with attentional problems, higher impulsivity and lower self-regulation at baseline consume more digital media later (37, 62, 64, 79), these effects may not be driven by parental motivation to regulate the child's behavior/emotion by digital devices. Based on our results, we argue it is likely that children with these problems are more prone to use digital devices, independently of how much their parents try to regulate their behavior with the device.

4.3 Limitations

To draw appropriate conclusions from the results, some limitations should be addressed.

PDER was solely measured by parent report and with only one item. More elaborate measures are required in future studies to corroborate the present findings, and parent reported PDER should be validated by behavioral observations. Parents also reported child self-regulation tendencies, which could lead to shared measurement bias. Replications with reports from preschool teachers or using different methodologies engaging parents more actively to support their recall memories or opinions about their child's behavior could advance future studies.

The internal consistency for impulsivity was lower than desirable (Cronbach's alpha was 0.629 in Wave 1 and 0.656 in Wave 2). This might have reduced the statistical power of the analysis to detect associations with PDER. Additionally, the dimensions of impulsivity and anger have rarely been used separately (90). Although their reliability has been frequently proven to be satisfactory (71, 73), the validity of these subscales is less known with few existing studies showing moderate correlations with other questionnaire scales (91), and low to moderate correlations with laboratory observational measures (92, 93). In the future, more studies are required to better corroborate the construct validity of these subscales.

Another potential confounder of the results is that data collection took place during a provincially declared state of emergency and lockdown because of the Covid-19 pandemic. Since digital device use increased during lockdowns (94, 95), our findings should be replicated in post pandemic contexts.

Additionally, convenience sampling may not be representative of the general population. This decreases the generalizability of the results to the whole population. Replications with larger sample are warranted. On the other hand, random sampling makes it impossible to separate the effects of screen time and PDER (as they are closely related). Therefore, further research is needed to disentangle their effects on self-regulation.

Lastly, the unretained sample differed from the retained sample in that parents in the unretained sample were younger and marginally used more PDER than the retained participants. This might have caused a systematic bias in the sample. Those who participated in the second data collection wave might be more conscious parents (applying less PDER), and this may distort the observed associations. For example, it is possible that the association between T1 effortful control and impulsivity and T2 PDER was not significant (and between T1 anger and T2 PDER was only marginally significant) because conscious parents try to find other ways besides digital media to regulate or engage the child. These shortcomings should be addressed in future studies.

4.4 Conclusion

Our study is the first longitudinal study revealing bidirectional associations between parental digital emotion regulation and child emotion-regulation skills. Results support that higher anger/frustration in the child renders parents tendentiously more likely use digital devices to regulate child emotions. However, while digital emotion regulation can be effective in the short term, this strategy may hinder child development of self-regulatory skills in the long term, leading to poorer effortful control and anger management. This process may lead to a positive feedback loop, resulting in increased dependence on the digital device and potential later problematic media use, "screen time tantrums" (40), and technological addiction (96). Based on these results, efforts should be made to call parents' attention on the harmful consequences of digital emotion regulation. Pediatricians, child psychologists, health professionals, and social workers working directly with families or performing home visits should ask parents about the use of digital media in the family. Additionally, they should be especially attentive to parents of children with difficult temperament, as they may be at higher risk of using PDER. These parents should receive as much support as possible

to reinforce emotion regulation methods other then PDER. In addition, peoples' awareness should be increased about digital devices being inappropriate tools for curing tantrums.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Université de Sherbrooke's IRB #2021-2927. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

VK: Writing – review & editing, Writing – original draft, Visualization, Funding acquisition, Formal Analysis, Conceptualization. M-AB: Project administration, Writing – review & editing, Writing – original draft. ÁK: Writing – review & editing, Writing – original draft. ÁP: Writing – review & editing, Funding acquisition. ÁM: Writing – review & editing, Funding acquisition. CF: Writing – review & editing, Methodology, Funding acquisition, Conceptualization.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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Process evaluation of a Germany-wide complex intervention to prevent dysregulated screen time in under threes: a RE-AIM-approach

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Background: Children's current screen time is well above current recommendations and is associated with many health consequences in the first years of life.
Methods: The complex intervention study "Screen free till 3" introduced parent education to a regular examination of 6-month-old children in outpatient pediatric practices. Pediatric practices were cluster-randomized in a 2:1 ratio (intervention group:control group). 2,581 pediatric practices received the intervention materials by cold call and participated by self-selection. The study includes a process evaluation that examines the implementation process. In this article, four different quantitative methods of the process evaluation are evaluated according to the RE-AIM scheme.
Result: 33.4% of pediatric practices confirmed their participation in the study. 10,391 parents took part in the pre-interventional app-based parent survey. 151 interested institutions contacted the research team by email. The majority (84.1%) asked to take part in the study. 518 pediatric practices took part in a telephone survey, of which 87.2% said that they are supported by the intervention materials and 91.6% would recommend the project to others.
Discussion: The RE-AIM analysis shows a high reach of parents via the app. The high adoption by pediatric practices and other institutions characterizes the relevance of the topic as well as the innovation of the study materials. After one and a half years, the intervention is firmly integrated into the structures of pediatric practices in Germany.
Trial register number: https://drks.de/search/en/trial/DRKS00032258, DRKS00032258.

KEYWORDS

birth cohort study, screen time, pediatrics, outpatient, complex intervention, randomized controlled trial, RE-AIM, healthcare research

1 Introduction

Screen exposure in early childhood can be associated with developmental impairments and health problems. The average screen time of children under 5 years of age worldwide ranges from 0.1 to 5 h in 2019 (1). A survey conducted among German mothers in 2022 revealed that the average screen time of 3- to 5-year-olds was 93 min for boys (77 min of television) and 83 min for girls (71 min of television) (2).

Specific risks associated with screen media exposure in early childhood are: delayed language development (3–5), learning problems, social-emotional delays, hyperactivity, inattention, aggressive and antisocial behavior (4). Early screen time is also negatively associated with fine motor and gross motor development (4). Positive correlations have been found between increased screen time and obesity (6, 7), insulin resistance and type 2 diabetes mellitus (8, 9), sleep problems (4) and myopia in preschool children (6, 10). Structural differences in the brain (11, 12) and altered cortical electroencephalography (EEG) activity affecting executive functions have been associated with increased screen use in preschool children (13).

There are guidelines to reduce the screen time of infants and toddlers. The World Health Organization, recommend no screens for children <2 years and a maximum of 60 min per day for children aged 2–4 years (14). The German AWMF guideline recommends screen time restriction for the first three years of life and a maximum daily screen time of 30 min per day for 3- to 6-year-olds (15). However, an observational study in France from 2022 shows that only a small proportion (13.5%) of parents adhere to the no screen guideline. Socio-demographic factors and high levels of screen time among parents were associated with non-compliance with the guideline (16). Qualitative research shows that some parents do not know the guidelines (17), are uninformed about the dangers of screen time in early childhood and instead see digital devices as an inevitable and necessary part of life (18). Parents use screens to keep children occupied, to keep them calm, and to help with difficulties such as mealtimes or teething (19). However, they also report that screen time of children and parents leads to conflicts between parents and children, to tantrum and aggression in children, and to conflicts between parents (20, 21).

In Germany, there is currently no intervention to prevent excessive screen media use by children under 3 years of age. Experts are therefore calling for more prevention and support services (22). Parent education may help to prevent or reduce children's screen time (23–25). However, previous interventions to reduce screen time in the first years of life have shown inconsistent effects on children's screen time (26). A process evaluation should evaluate the implementation process of such an intervention in terms of content and context (27). This increases effectiveness and provides an example for the development of further complex interventions.

2 Materials and methods

2.1 The complex intervention study

To our knowledge, the "Screen free till 3" (BB3)-study is the world's largest intervention study to date on the prevention of screen media use in children under the age of three (28). The University of Witten/Herdecke initiated the study in cooperation with the Professional Association of Pediatricians in Germany (BVKJ) and BVKJ-Service GmbH (BVKJ-S) in 2022.

The cluster-randomized controlled trail evaluates the complex intervention with a mixed-methods design. Pediatric practices were randomized 2:1 (intervention group:control group). In 2022, the intervention group ($n = 2{,}581$ pediatric practices) received the intervention materials in cold calling. Participation was by self-selection. The control group did treatment as usual. Parents of children from intervention and control practices take part in the longitudinal parent survey. The parent survey in the BVKJ's practice app examines screen time, time in nature and children's development from six months to three years of age. In addition, a mixed-methods process evaluation evaluated the implementation process of the complex intervention and the contextual factors.

2.2 Study design of the process evaluation

The process evaluation was based on the logical model of the BB3 intervention and the MRC Guidance (29) for the process evaluation of complex interventions. The basic aim of the process evaluation was to examine the implementation process of the intervention study. The objectives were as follows: (1) To evaluate the implementation process in pediatric practices. (2) To evaluate the reach and effectiveness of the intervention in relation to parents. The RE-AIM scheme (Reach, Effectiveness, Adoption, Implementation, Maintenance) (30, 31) represented the implementation process of the intervention (Table 1).

2.3 Data collection and analysis

2.3.1 Data collection

2.3.1.1 Practice documentation

The practice documentation documents the participating and non-participating intervention practices and the communication process.

2.3.1.2 Telephone survey

In 2022, a call centre conducted a telephone survey with a random sample of 800 pediatric practices from the intervention group. This comprised eight questions about the materials and the implementation of the intervention.

2.3.1.3 Parent survey

The longitudinal parent survey in the practice app includes children born in 2022. Parents fill out a questionnaire at four points in time according to the age of the children (6 months, 1

TABLE 1 Framework of the process evaluation of BB3 intervention study.

RE-AIM	Project definition	Data type and source
Implementation process		
Reach	Absolute number, proportion and representativeness of participants in the app survey; use of the project website	App survey, website analysis
Effectiveness	Economic effects of the intervention on the pediatric practices and other reasons for or against participation; behavioral prevention or change of the parents in group comparison; development parameters of the children in group comparison	App survey
Adoption	Absolute number, proportion, and representativeness of participating practices and of interested institutions	Practice documentation, website analysis
Implementation	Fidelity, protocol-compliant implementation in practices; applicability of the intervention; adaptations made to interventions and implementation strategies	Telephone survey, practice documentation
Maintenance	Extent to which the intervention becomes part of the routine organizational practices and guidelines and is maintained at the individual level	Practice documentation app survey

year, 2 years and 3 years). The first questionnaire is pre-interventional. The following questionnaires are post-interventional. The survey records the daily screen time and the child's development.

2.3.1.4 Website analysis

The website analysis evaluated the frequency of use of the project website, registrations for the parent newsletter and inquiries via the contact form on the project website.

2.3.2 Data analysis

The data from the quantitative surveys were exported to Excel and Statistical Package for Social Sciences (SPSS) for analysis. The distributions of the collected data were described separately for the different collectives using suitable descriptive statistical parameters.

3 Results

3.1 Reach

The first pre-interventional parent survey (June 2022 to October 2023) gave 36,431 parents the opportunity to participate. There was the questionnaire on sociodemographic (quest 1) and the questionnaire with questions about screen time and child development (quest 2). 28.5% (10,391) completed quest 1 and 17.8% (6,469) completed quest 2. Participants were mothers (94.1%), fathers (5.7%) and foster parents or others (0.2%). This data came from 786 practices throughout Germany. We have published the more detailed results of the baseline survey separately (28).

The project website received 45,883 visits from June 2022 to December 2023. 94% of the visits came from Germany, followed by Austria, Switzerland, Belgium, and the USA. On average, visitors performed 5.4 actions per page. Over the entire period, the homepage had 38.5% of total views. The most clicked content after the homepage was background information on the study (23.5%), tips and tricks (7.5%) and frequently asked questions (7.4%). The English-language homepage had 2.4% of total views. The information pages for pediatric practices had 3.7% of visits. Until December 2023, 699 readers have subscribed to the email newsletter.

3.2 Effectiveness

We are evaluating the effectiveness of the intervention via the parent survey as well as parent and expert interviews. We will publish the results separately.

3.3 Adoption

In May 2022, the 2,581 pediatric practices in the intervention group received the first package with intervention materials and study information in cold calls. Self-selection without exclusion criteria by the pediatric practices determined the actual sample size. At the time of writing this manuscript, 33.4% of pediatric practices (861) had already confirmed their participation in the study. The relative proportion of participating practices in relation to non-participating intervention practices per federal state averages 33.3% (median = 33.0%) describes a symmetrical distribution. Nine practices from the intervention group (0.3%) informed the research team by email that they did not wish to participate in the study (Table 2).

By December 11, 2023, 151 people interested in the project had sent an email request. These were doctors from the control group (51.7%), child day care and schools (10.6%), family support and counseling (9.9%), offices and administration (8.6%), therapy (7.3%) and clinics and others (6.0%). The reasons for the inquiries were requests for material and information on the study (84.1%), cooperation and support for the study, e.g., through public relations work (9.3%), suggestions for improvement such as translation into other languages (3.3%), requests for speakers (2.6%) and other (0.7%).

3.4 Implementation

In July 2022, a telemarketing agency contacted a random sample of 800 pediatric practices from the intervention group. Five hundred and eighteen pediatrician practices participated. The medical assistants answered most frequently (96.0%). 87.3% (452) of pediatric practices confirmed that they had received the BB3-intervention materials. 91.4% (413) of respondents

TABLE 2 Germany-wide distribution of pediatric practices from the intervention group participating in self-selection by state.

Distribution of pediatric practices from the intervention group				
	Randomized intervention group	Participation confirmed	% of participation confirmed	% by intervention group by state
Total	**2,581**	**861**	**100.0**	**33.4**
Baden-Wuerttemberg	351	134	15.6	38.2
Bavaria	448	157	18.2	35.0
Berlin	153	44	5.1	28.8
Brandenburg	93	12	1.4	12.9
Bremen	21	6	0.7	28.6
Hamburg	64	23	2.7	35.9
Hesse	176	58	6.7	33.0
Mecklenburg-Vorpommern	30	14	1.6	46.7
Lower Saxony	199	86	10.0	43.2
North Rhine-Westphalia	568	169	19.6	29.8
Rheinland-Pfalz	107	31	3.6	29.0
Saarland	33	10	1.2	30.3
Saxony	125	42	4.9	33.6
Saxony-Anhalt	79	25	2.9	31.6
Schleswig-Holstein	80	26	3.0	32.5
Thuringia	54	24	2.8	44.4
	Randomized intervention group	Participation refused		% by intervention group by state
Total		**9**		**0.3**
Baden-Wuerttemberg	351	1		0.3
Bavaria	448	1		0.2
Hamburg	64	1		1.6
Lower Saxony	199	2		1.0
North Rhine-Westphalia	568	3		0.5
Saxony	125	1		0.8

Bold values: total sample; randomized intervention group: number of practices that were randomized to the intervention group; participation confirmed: number of practices that have confirmed their participation; participation refused: number of practices that have refused to participation; % by intervention group by state: proportion of practices from the intervention group, per state participating or not participating.

confirmed that they had already advised against screen media in early childhood before the start of the BB3 intervention, 4.6% (21) did not. 87.2% (394) of pediatric practices reported that the intervention helped them with parent counseling in the practice. This was not the case for only 7.5% (34). 91.6% (414) of respondents confirmed that they would recommend the project to other pediatric practices.

3.5 Maintenance

During the study period, we sent intervention material and reminders to the intervention practices several times by post and e-mail. Pediatric practices also had the option of reordering intervention materials via website. By December 2023, 128 pediatric practices had reordered further study materials.

4 Discussion

With a participation rate of at least 33.4% of the pediatric practices invited to the study, the pediatricians accepted the BB3 intervention study very well. The expected recruitment rate of general practitioner practices for outpatient research projects is 3% to 4% (32). The high participation rate with a symmetrical, Germany-wide distribution is possibly due to the urgency of the topic "digitalization in early childhood". High number of e-mail inquiries from the control group and other institutions underlines the relevance of the topic. "Screen free till 3" can also be implemented and expanded through family support and counseling, daycare and schools, therapy, offices, and clinics. A qualitative analysis of an intervention study with parent education on screen time found that parents trust the information provided by a health advisor (33). In addition, a study with parent education in kindergartens showed a reduction in screen time for children with pre-interventional screen time of ≥2 h per day (34). Parents seem to trust the information from professionals regarding screen use and limit the screen time for their children.

The practice app was used to reach 10,391 parent-child pairs for participation in the parent survey, which corresponds to around 1.4% of all children born in Germany in 2022 (738,819) (35). The study has a large birth cohort that evaluates screen use and child development longitudinally up to the age of three. Many studies only measure the time and devices children use (36–38). Increased screen time by parents may be a risk factor

for non-compliance with screen time guidelines (16). In addition, parental use of digital devices hinders interaction between parent and child (20, 21). The BB3 study examines the effect of parents' screen time in presence of the child and internet behavior on child's screen time and development (28).

A multicenter cross-sectional study in France from 2021 showed that only 22.7% of parents received education about screen exposure in early childhood from their doctor. Of these, 53.1% did so on their own initiative (39). The intervention materials enables structured parent education at every regular examination. The intervention materials supports the pediatricians. The majority of the pediatric practices contacted said they would recommend the project to others. This underlines the acceptance and practicability by pediatricians. High screen time in infants and toddlers is associated with parental education and other sociodemographic factors (1, 16, 40). An intervention via the pediatrician for a regular examination reaches almost all parents in Germany and can potentially minimize this effect.

Qualitative studies have already found that parents are often unaware of the risks of screen media exposure, see the use of digital devices as integrated and relevant in everyday life, and also have difficulty reducing their child's screen time (17, 18, 20). The qualitative part of the process evaluation separately examines which of these factors also apply to German families. In addition, the qualitative analysis examines whether these factors can be reduced through early intervention at the age of 6 months. In interviews, parents and grandparents report that the use of digital media often leads to conflicts with small children or tantrum and aggression (20). The no screen guideline may reduce these effects.

There are possible limitations with regard to the results. The reported participation rate may differ from the real participation rate. It is possible that many pediatric practices use the intervention materials without confirmation of participation, as they regularly receive materials without ordering them. The majority of respondents to the telephone survey were medical assistants. Especially in large practices, it can happen that a person is reached on the phone who is not involved in the BB3-intervention study in their area of activity. Consequently, the results of the telephone survey (participation, recommendation, etc.) may differ from the real results.

In summary, the BB3 intervention has been successfully implemented in many pediatric practices in Germany based on an assessment according to the RE-AIM scheme. After one and a half years, the intervention had a wide reach among pediatricians, and was noticed and endorsed by numerous institutions. The large number of interested institutions reflects the relevance of such a project and offers many opportunities to firmly establish the BB3 intervention. The process evaluation also showed how the practice app achieved a high number of participating parents.

Data availability statement

The datasets presented in this article are not readily available because they are not anonymized (in the case of the practice documentation) and we received them from the call center (in the case of the telephone survey). Requests to access the datasets should be directed to juliane.schemmer@uni-wh.de.

Ethics statement

The studies involving humans were approved by ethics committee of the University of Witten/Herdecke. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

JS: Data curation, Formal analysis, Methodology, Writing – original draft. DM: Conceptualization, Investigation, Writing – review & editing. HK: Conceptualization, Writing – review & editing. TM: Conceptualization, Data curation, Formal analysis, Writing – review & editing. AE: Writing – review & editing. SM: Writing – review & editing. SS: Conceptualization, Investigation, Supervision, Writing – review & editing, Writing – original draft.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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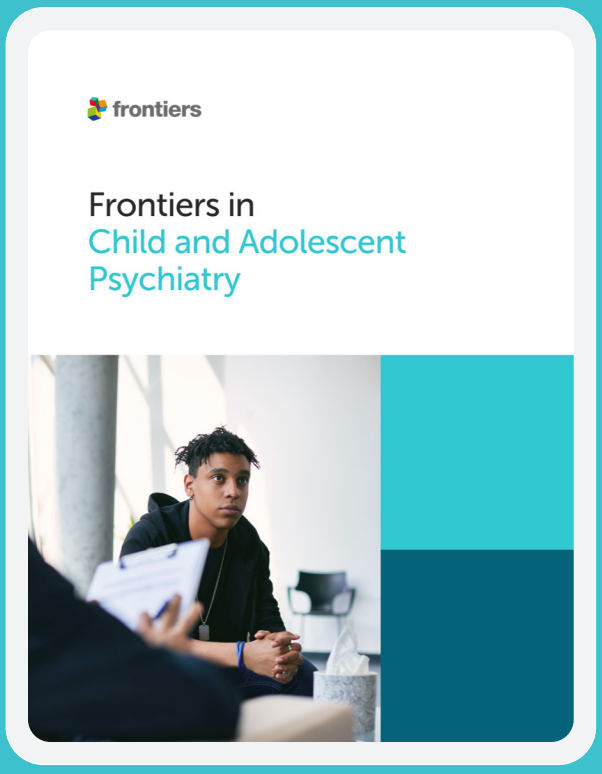

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