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Preschoolers' high-dose electronic media use and its association with their psychosocial well-being at five years of age

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Abstract

Objectives This study investigated the frequency of preschooler's electronic media (e-media) usage and the risks of high-dose e-media use on young children's psychosocial well-being.

Design We study longitudinal associations between e-media use at 18 months and psychosocial symptoms at five years of age, as well as cross-sectional associations between e-media use and psychosocial symptoms at five years.

Setting Between 2011 and 2017 in Finland.

Participants Children aged 5 years (N=699).

Primary and secondary outcome measures Children's psychosocial symptoms were asked at the age of five years using the parent-reported questionnaires Five-to-Fifteen (FTF) and the Strengths and Difficulties Questionnaire (SDQ).

Results Based on our results, 95% of the preschoolers exceed the daily electronic media use recommendation set by health professionals. Our results indicate that increased screen time at five years of age is associated with a risk of multiple psychosocial symptoms (OR 1.53-2.18, 95% CI: 1.05-3.20, $p<0.05$), while increased levels of e-media use at 18 months was only associated with FTF peer problems (OR 1.59, CI: 1.04-2.41, $p=0.03$). Moreover, high-dose use of electronic games at the age of five years seems to be associated with fewer risks for psychosocial well-being than program viewing, as it was only associated with SDQ hyperactivity (OR 1.65, CI 1.49-3.20, $p=0.02$).

Conclusion Increased screen time has multiple risks for children's psychosocial well-being. These risk factors might accumulate in the long term, and cause problems in children's socio-emotional development later on. Health professionals and pediatricians have an important role as communicators of the current research results on the safe usage time of e-media for families, and enhance parents' skills as regulators of children's safe e-media use. In the future, more research is needed on the family conditions of high-dose e-media users.

Strengths and limitations of this study

- A major strength of our study is the longitudinal study setting and repeated measurement of e-media exposure.
- Additionally, patterns of children's electronic media use are rapidly changing, and our study offers results on the associations of young children's e-media usage with their psychosocial well-being based on recent data.
- The limitation of our study is the measurement of e-media use that was based on parental questionnaires and not logs.
- Moreover, the sample is based on a representative birth cohort recruited during pregnancy and therefore it is not affected by selection bias, although those with lower education seem to be underrepresented in the sample, as are single mothers.

Preschoolers' high-dose electronic media use and its association with their psychosocial well-being at five years of age

Introduction

In recent years, as digital technology has rapidly developed, electronic media (e-media) has become an almost universal part of young children's daily life. Even at preschool age, e-media use is already a popular sedentary behavior (1). Traditional e-media is often used: nearly half of preschool-age children watch TV (2), use a laptop or desktop computer, and play video consoles daily (3). However, the pattern of how media is used has changed considerably in recent years, as preschool children's use of mobile devices has tripled from 2013 to 2017, although the overall amount of e-media use has remained relatively stable (2). Recent studies also report that a large proportion (81.3%) of 4-year-old children play games, use applications, or watch videos on mobile devices daily (3).

The World Health Organization (WHO) has published guidelines for e-media use of children aged 2-4. The recommendation is a maximum of one hour per day for this age group (4). However, in previous studies, much higher amounts have been reported. For example, among American children aged 2-4, the average total screen time per day was 159 minutes (2), and among Finnish children aged 3-6 it was 111 min (5). It seems that parents may be unaware of the potential risks of high-dose e-media usage for their children's psychosocial well-being. Studies have even pointed out that some parents use e-media devices as a tool to calm down their children (6,7), especially when the child has social emotional difficulties (6). Furthermore, studies suggest that frequent e-media use in family households might interrupt parent-child interaction, which might cause problems in children's social-emotional development (1,8–10).

Based on the research, it seems that a high amount of program viewing is a risk for preschool-age children's psychosocial well-being (8). It is associated with externalizing problems, such as hyperactivity (10,11) and conduct problems (11–13), and also with peer problems (14). However, fewer studies have investigated the associations between electronic game-playing and preschool-age children's psychosocial well-being (11,15,16). According to these studies, it seems that electronic game-playing might be less detrimental and may even have some positive effects on children's socio-emotional skills (15). Nonetheless, the use of electronic games and computers are associated with internalizing problems, such as emotional problems (16).

As the pattern of children's electronic media usage is rapidly changing, the updated data on the degree of e-media usage and its significance on well-being is needed. Moreover, although there is evidence showing the harmful effects of preschool-age children's high-dose e-media use on their well-being, few of these studies have analyzed the longitudinal associations of early exposure of e-media to children's later psychosocial problems. According to these studies it seems that high-dose e-media use that starts at early age might be detrimental for young children's psychosocial health later on (10,11,16).

The aim of this research is to assess the amount of preschooler's e-media usage and its associations with their psychosocial well-being. We study longitudinal associations between e-media use at 18 months and psychosocial symptoms at five years of age, as well as cross-sectional associations between e-media use (program viewing and electronic game-playing) and psychosocial symptoms at five years. Psychosocial symptoms, i.e., internalizing and externalizing problems, were assessed at five years of age. We hypothesized that children who consume large amounts of e-media at 18 months of age have more psychosocial symptoms at five years than those who use less. Moreover, we hypothesized that program viewing is associated with more problems in psychosocial health, while use of e-games has less associations with negative outcomes.

Method

Study design

This study is part of a larger Finnish CHILD-SLEEP longitudinal birth cohort study, which includes several measurement points. The study design, protocol, participants, and measures have been described in more detail in Paavonen et al. (2017). The recruitment and baseline measurement took place prenatally at the 32nd week and the follow-up measurements occurred at the birth of the child and at three, eight, 18, 24 and 60 months of age. Moreover, records from the maternity hospital and maternity clinics were collated. The study protocol was approved by the local Hospital District Ethical Committee (9.3.2011, ethical research permission code R11032). Permission for the recruitment procedure was also received from the leading doctors of the targeted health centers. Participants were also asked to give their written informed consent.

Participants

Mothers and fathers were recruited for the study in the Pirkanmaa Hospital District area in Southern Finland. Altogether, 2244 parents gave their approval to receive prenatal questionnaires when they visited the maternity clinics, and 1679 (74.8%) of them gave their consent to participate in the study and returned the baseline questionnaires. The response rate at 5 years of age was 42.5% (N=714). Children with severe chronic illnesses or disabilities, e.g., Down's syndrome or Hirschsprung disease (n=7), and all twins (n=8) were excluded. The final sample included 699 children whose parents had answered the Strengths and Difficulties Questionnaire (SDQ) (18) or the Five-to-Fifteen (FTF) (19) questionnaire at the children's age of 5 years. The questionnaire at 5 years of age included SDQ and e-media usage questions and was answered by the parents of 653 children. The FTF questionnaire was answered by the parents of 668 children. In addition, the 18-months questionnaire, which included children's media usage questions at that age, was available for 585 (out of 699) children. Information concerning parental sociodemographic factors such as education and number of previous children were asked prenatally and they were available for 641 children.

Measures

Screen time

Parents reported the time a child spent engaging in electronic media activities at both 18 months and 5 years of age. Separate questions were asked for weekday and weekend e-media use on how many hours a child watches programs (including on television or other devices), and (at 5 years) how many hours a child participates in electronic game-playing (on a computer, console devices, cell phones, tablets, or other devices).

For the analyses, we first recoded all the reported electronic media use measures into minutes. Second, we calculated a weighted daily average (5/7 on weekdays and 2/7 at weekends) of the measures. At 18 months the daily average for program viewing ranged from 0 to 253 minutes. At 5 years, separate measures for program viewing (range 225) and game-playing (range 182) were calculated, as well as the total screen time per day, by totaling both electronic media use measures (range 321). Finally, each of the electronic-media use measures (program viewing, game-playing, total screen time) was dichotomized using a 75 percentile cut-off to indicate those with the highest dose of e-media use: Program viewing at 18 months of age ≥ 46 mins per day (24.4%, n=143), program viewing at 5 years of age ≥ 88 mins per day (24.3%, n=161), use of electronic games at 5 years of age ≥ 45 mins per day (19.3%, n=126), total screen time at 5 years of age ≥ 135 mins per day (24.6%, n=160).

Outcomes

Children's psychosocial symptoms were asked at the age of five years using two different parent-reported questionnaires: the FTF and the SDQ.

The FTF questionnaire is tested for its validity and reliability for the identification of internalizing and externalizing symptoms in children aged five to fifteen years (19,20). The items are categorized into eight different domains and 22 subdomains, of which we used the following four subdomains: Attention and concentration difficulties, hyperactivity and impulsivity, emotional internalizing problems, and emotional externalizing problems (21).

The SDQ children's questionnaire includes 25 items and five scales, with five items in each. It is a validated instrument to detect psychosocial problems in preschool-aged children (18), and is widely used for research purposes (11,16). In this research, we used four subscales: Hyperactivity, emotional problems, conduct problems, and peer problems.

Children scoring in the 75th percentile or over in SDQ and FTF subscales were considered to have clinically elevated levels of psychosocial symptoms. The cut-off points for the FTF scales sum scores were: Attention and concentration problems ≥ 6 (26%, n=172), hyperactivity and impulsivity ≥ 6 (27.9%, n=185), emotional internalizing problems ≥ 2 (22.3%, n=152), and emotional externalizing problems ≥ 4 (22.9%, n=152). Accordingly, the cut-off points for the SDQ scale sum scores were: Inattention-hyperactivity ≥ 5 (25.7%, n=171), emotional problems ≥ 2 (18.6%, n=124), conduct problems ≥ 3 (32.8%, n=218), and peer problems ≥ 3 (25.1%, n=167).

Covariates

We used child's age (years, continuous), gender, number of siblings, participation in a full-time daycare (no vs. yes), and parent's education (university vs. less) as covariates that were adjusted in the statistical analyses.

Statistical analyses

Data was analyzed using IBM SPSS statistics version 25. Frequencies of categorical/dichotomous variables as well as means and standard deviations of the continuous study variables were calculated first (see tables 1 and 2). Then, logistic regression analyses were conducted to calculate odds ratios and their 95% confidences intervals for the associations between electronic media use at 18 months and five years of age and each of the subscales of FTF and SDQ (see tables 3 and 4). In addition to the bivariate (crude) analyses, two adjusted logistic regression models were conducted: In the first model, the child's age, gender, parents' education and screen use at 18 months of age (in the analyses at five years), and in the second, fully adjusted model, the number of siblings and information on full-time daycare participation were also added to the model.

Results

Descriptive statistics of the sample are presented in **Table 1**. The mean age of the children in the sample was 5.7 years (SD=0.5). The sample consisted of 333 girls (n=47.6%) and 366 boys (52.4%). The majority of the children (67.7%) were in full-time daycare. Most of the parents (63.4%) had a university-level degree.

On average, at 18 months of age, children spent 32.4 (SD 31.0) minutes per day with electronic media devices. At five years the amount was 114.1 minutes (SD 50.6) per day (range 321). Program viewing (mean 80.4, SD 36.3) was more popular than the use of electronic games (mean 33.4, SD 25.9).

At 18 months, 22.7% of the children spent over 60 minutes consuming screen media each day, while at 5 years of age the percentage was 94.6%. Moreover, 66.8% of the children viewed programs for more than 60 minutes per day, whereas 10.6% of the children spent more than 60 minutes per day using electronic games.

The sample was generally normative, with low levels of emotional and behavioral symptoms. The mean scores for each of the subscales of psychosocial problems based on SDQ and FTF scales are reported in **Table 2**.

Table 3 reports the odds ratios for the associations between electronic media use at 18 months and five years of age on each of the subscales of FTF and SDQ. Based on the results, electronic media use at 18 months had less of a negative effect than at five years of age: A high amount of screen time at 18 months was associated with an increased risk of SDQ peer problems (OR 1.59, p=0.03). The association was significant after children's age, gender, and parent's SES were adjusted (OR

1.64, p=0.03). There was no increased risk of psychosocial problems with other subscales of FTF and SDQ.

In contrast, elevated levels of total screen time at five years of age were associated with multiple psychosocial problems: FTF attention and concentration difficulties (OR 1.88, p<0.01), hyperactivity and impulsivity (OR 1.57, p=0.03), internalizing symptoms (OR 1.75, p=0.01), and externalizing symptoms (OR 1.69, p=0.01). Moreover, it was associated with SDQ hyperactivity (OR 2.18, p<0.01) and conduct problems (OR 1.53, p=0.03). After fully controlling for the confounding factors, there were no other significant associations than the increased risk of FTF internalizing symptoms (OR 2.01, p=0.01).

Table 4 presents the odds ratios for the associations between program viewing and the use of electronic games on each of the subscales of FTF and SDQ among children at five years of age. A high amount of program viewing was associated with an increased risk of psychosocial problems, while the use of electronic games seemed less problematic. Program viewing at five years of age had an association with all of the FTF subscales (OR 1.64-1.98, p<0.05) and with SDQ hyperactivity (OR 2.43, p<0.01) and conduct problems (OR 1.48, p=0.04). In the fully-adjusted model, an increased risk appeared for attention and concentration difficulties (OR 1.91, p=0.01) and hyperactivity and impulsivity (OR 1.67, p=0.03), and with SDQ hyperactivity (OR 2.23, p<0.01). In contrast, the use of electronic games was associated with an increased risk of SDQ hyperactivity (OR 1.65, p=0.02) and only in the unadjusted model, while with the other subscales no increased risk appeared.

Discussion

The aim of this study was to investigate the frequency of preschooler's e-media usage and the risks of high-dose e-media use on young children's psychosocial well-being. The results of our study show that 95% of preschoolers exceed the daily electronic media use recommendation of one hour, which is set by health professionals and pediatricians. Based on our results, increased screen time at five years of age was associated with a risk of multiple psychosocial symptoms, while increased levels of e-media use at 18 months had only few longitudinal associations for psychosocial symptoms at five years of age. Furthermore, high-dose use of electronic games at the age of five years seemed to be associated with fewer risks of psychosocial well-being than program viewing.

Based on the results of this study, preschoolers' average daily screen time is 114 minutes at five years of age. This number is almost two times higher than the recommended daily maximum amount of e-media, which is 60 minutes (4,22). Previous studies on preschoolers' e-media use conducted in Finland have reported similar results, as the total daily screen time was 111 minutes in 2017 (5), while in Belgium it was 81 minutes (23) in 2018. Among American children, the total screen time in 2017 in this age group was somewhat higher: 159 minutes (2). It has been suggested that the products and usage culture of electronic media develops very rapidly in United States (2,24), whereas access to products might occur at a slower pace in other countries. This might explain why the frequency of usage among young children in the US is higher than in Europe.

We discovered that high screen use at 5 years of age was associated with a risk of multiple psychosocial problems. More precisely, elevated levels of total screen time were associated with attention and concentration difficulties, hyperactivity and impulsivity, emotional internalizing and externalizing symptoms, and conduct problems. Similar results have been recently reported on emotional symptoms (11,16,25), conduct problems, and hyperactivity (25). Previous studies have also reported associations between increased total screen time and peer problems (25). We did not find such associations at five years. This difference might be explained by the age of the participants: In the study of Wu et al. (2017) the mean age of the participants was 4.37, whereas in our study it was 5.68. In line with this, our findings show that screen time at an earlier age, i.e., at 18 months, was associated with peer problems later on. It seems that a high amount of screen use at a younger age is a risk factor for peer problems. However, unlike some other studies (10,11,16), we did not find high-dose use of electronic devices at 18 months of age to be associated with other problems in psychosocial well-being later on. It is feasible that parents regulate younger children's e-media usage habits, while later on, other factors such as a child's personality traits or their participation in daycare may have a more important role in the amount of usage.

Our results show that an increased amount of program viewing at 5 years of age is associated with a risk of several psychosocial problems, while electronic game use had fewer associations, which is also consistent with recent previous studies (11,15,16). Electronic game-playing was only associated with SDQ hyperactivity, whereas no risks were found regarding other psychosocial symptoms. Previous studies have yielded an association between electronic game-playing and emotional symptoms. However, the direction of the association is contradictory: Increased e-game use has been associated with emotional problems (16), but also with better socioemotional skills (15). The few associations between socioemotional health and game-playing might be explained by the social nature of game-playing: Children often participate in the use of e-games with siblings and other family members, for example, and develop their social and emotional skills in these social interactions (15). All in all, the amount of daily e-game usage in our study and all of these other studies was much lower compared to program viewing, which might explain why e-games are not associated with psychosocial problems to any larger extent at this age.

As our results point out, increased screen time has multiple risks for children's psychosocial well-being. These risk factors might accumulate in the long-term, and cause problems in children's socio-emotional development later on. Health professionals and pediatricians play an important role as communicators of the current research results on the safe usage of e-media for families. Parents' knowledge might further help them to set safe boundaries for young children's e-media use and protect children's psychosocial health from associated risk factors (26).

One possible mechanism accounting for the result might be that the time children spend on e-media reduces the time spend on constructive activities, such as interactions with family members, reading and playing (1,8,9). At an early age, children's socio-emotional development occurs in a dynamic interplay between social learning and environmental factors. Furthermore, if the surrounding environment does not offer enough means for a child's healthy development, it might affect a children's psychosocial well-being (27). Genetic dispositions also play a role in modifying individual risks. However, the direction of the effect of e-media use is unclear, as some parents

might use e-media devices as a tool to calm their children down, especially when the child has socio-emotional difficulties (6).

One strength of our study is its longitudinal study setting and its repeated measurement of e-media exposure. Moreover, patterns of children's electronic media usage are rapidly changing, and our study offers results on the associations between young children's e-media use and their psychosocial well-being based on recent data. In addition, the sample is based on a representative birth cohort recruited during pregnancy and therefore it is not affected by selection bias, although those with lower education seem to be underrepresented in the sample, as do single mothers (17). The measurement of e-media use was based on parental questionnaires and not logs, such as in the previous similar study (5). However, the reported exposures are very much in line with previous studies and therefore this seems to have a negligible influence on the findings. In the future, more research is needed on the family conditions of high-dose e-media users.

Conclusion

This study reported the risks associated with high-dose use of electronic media devices by young children. Our results show that 5-year-old children spend considerably more time on e-media than is recommended by professionals. Our results further indicate that high levels of e-media use, especially program viewing, is associated with problems with psychosocial outcomes, while e-games play a lesser role among five-year-olds. Children's social-emotional development is influenced by environmental factors, including electronic media habits. Although children's electronic media use patterns might not seem problematic when considering use on a daily level, they do have risks in the long term. Thus, health professionals play a key role in providing information for parents on screen media parenting, i.e., the safe use of e-media devices among young children in order to protect their healthy development.

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Contributorship statement

EJP and OSH designed the study. JN, OK, and EJP were primarily responsible for data analysis and writing of the article. RV and AK contributed critically to the writing of the article.

Competing interests

The authors declare no competing interests.

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Data sharing statement

Data is not publicly available due to legal restrictions and confidential nature of the data. Data is available upon request. Requests may be sent to The Finnish Institute for Health and Welfare, who is the controller of the data. For more information about data access, please see https://thl.fi/en/web/thlfi-en/statistics/information-for-researchers.

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Table 1. Descriptive statistics of sociodemographic factors and measures of screen time (N=699)

	% (N)
Sociodemographic factors	
Child's gender	
Girls	47.6 (333)
Boys	52.4 (366)
Child's age, years; mean (SD)	5.68 (0.54)
Parent's education	
University-level degree	63.4 (409)
Less than university-level degree	36.6 (236)
Number of siblings	
0	51.0 (327)
1	32.2 (207)
2	12.9 (83)
3	2.5 (16)
4 or more	1.2 (8)
Full-time daycare	
No	32.3 (214)
Yes	67.7 (448)
Screen time	
Total screen time at 18 months, min; mean (SD), range	32.4 (31.0), 252.9
Over 60 minutes, %	22.7 (136)
Over 120 minutes, %	2.8 (17)
Program viewing at 5 years, min; mean (SD), range	80.4 (36.3), 225.0
Over 60 minutes, %	66.8 (442)
Over 120 minutes, %	16.9 (112)
Electronic game-playing at 5 years, min; mean (SD), range	33.4 (25.9), 182.1
Over 60 minutes, %	10.6 (69)
Over 120 minutes, %	2.3 (15)
Total screen time at 5 years, min; mean (SD), range	114.1 (50.6), 321.4
Over 60 minutes, %	94.6 (615)
Over 120 minutes, %	40.2 (261)
Over 180 minutes, %	11.5 (75)

Table 2. Outcome variables.

Outcome variable	Mean (SD)	Range
FTF		
Attention and concentration difficulties	3.75 (3.41)	18.00
Hyperactivity and impulsivity	3.98 (3.63)	18.00
Emotional/internalizing symptoms	1.52 (1.79)	15.00
Emotional/externalizing symptoms	2.83 (3.25)	21.00
SDQ		
Hyperactivity	3.04 (2.34)	10.00
Emotional problems	1.38 (1.48)	9.00
Conduct problems	1.97 (1.59)	9.00
Peer problems	1.69 (1.38)	9.00

Table 3. Associations between electronic media use at 18 months and 5 years of age with psychosocial well-being.

Screen time: 18 months of age	***Crude***			***Adjusted 1*** [a]			***Adjusted 2*** [b]		
FTF	***OR***	***95% CI***	***p***	***OR***	***95% CI***	***p***	***OR***	***95% CI***	***p***
Attention and concentration difficulties	1.46	0.96-2.22	0.07	1.50	0.97-2.31	0.07	1.41	0.89-2.22	0.14
Hyperactivity and impulsivity	1.16	0.76-1.77	0.50	1.16	0.75-1.81	0.50	1.14	0.72-1.80	0.59
Emotional/internalizing symptoms	1.19	0.76-1.88	0.45	1.15	0.72-1.85	0.55	1.13	0.69-1.86	0.62
Emotional/externalizing symptoms	1.03	0.66-1.60	0.91	1.04	0.65-1.65	0.88	1.06	0.65-1.72	0.82
SDQ									
Hyperactivity	1.49	0.98-2.26	0.06	1.37	0.89-2.12	0.15	1.37	0.87-2.18	0.18
Emotional problems	1.36	0.86-2.17	0.19	1.38	0.85-2.23	0.19	1.47	0.88-2.45	0.14
Conduct problems	1.24	0.84-1.84	0.28	1.26	0.84-1.90	0.27	1.23	0.80-1.90	0.35
Peer problems	**1.59**	**1.04-2.41**	**0.03**	**1.64**	**1.06-2.52**	**0.03**	1.56	0.98-2.46	0.06
Total screen time: 5 years of age									
FTF	***OR***	***95% CI***	***p***	***OR***	***95% CI***	***p***	***OR***	***95% CI***	***p***
Attention and concentration difficulties	**1.88**	**1.27-2.80**	**<0.01**	1.45	0.92-2.28	0.11	1.57	0.97-2.53	0.07
Hyperactivity and impulsivity	**1.57**	**1.06-2.33**	**0.03**	1.33	0.85-2.12	0.22	1.31	0.81-2.13	0.28
Emotional/internalizing symptoms	**1.75**	**1.15-2.65**	**0.01**	**1.84**	**1.14-2.97**	**0.01**	**2.01**	**1.21-3.34**	**0.01**
Emotional/externalizing symptoms	**1.69**	**1.12-2.55**	**0.01**	1.39	0.87-2.23	0.17	1.54	0.94-2.52	0.09
SDQ									
Hyperactivity	**2.18**	**1.49-3.20**	**<0.01**	**1.60**	**1.02-2.49**	**0.04**	1.55	0.97-2.48	0.07
Emotional problems	0.99	0.62-1.56	0.95	0.98	0.58-1.66	0.94	0.90	0.49-1.61	0.70
Conduct problems	**1.53**	**1.05-2.21**	**0.03**	1.24	0.81-1.91	0.32	1.06	0.67-1.67	0.80
Peer problems	1.06	0.71-1.60	0.77	0.90	0.56-1.45	0.67	0.85	0.51-1.42	0.53

[a] Adjusted for age, gender, parent's education. Total screen time at 5 years of age: Also adjusted for screen time at 18 months of age.

[b] Adjusted for age, gender, parent's education, number of siblings, and daycare participation. Total screen time at 5 years of age: Also adjusted for screen time at 18 months of age.

Table 4. Associations between program viewing and use of electronic games at 5 years of age with psychosocial well-being.

Program viewing: 5 years of age	***Crude***			***Adjusted 1*** [a]			***Adjusted 2*** [b]		
FTF	***OR***	***95% CI***	***p***	***OR***	***95% CI***	***p***	***OR***	***95% CI***	***p***
Attention and concentration difficulties	**1.98**	**1.34-2.93**	**<0.01**	**1.71**	**1.10-2.69**	**0.02**	**1.91**	**1.19-3.08**	**0.01**
Hyperactivity and impulsivity	**1.64**	**1.11-2.42**	**0.01**	**1.68**	**1.07-2.63**	**0.02**	**1.67**	**1.04-2.69**	**0.03**
Emotional/internalizing symptoms	**1.68**	**1.11-2.54**	**0.01**	1.59	0.99-2.55	0.06	**1.71**	**1.03-2.84**	**0.04**
Emotional/externalizing symptoms	**1.69**	**1.12-2.55**	**0.01**	1.14	0.71-1.84	0.59	1.19	0.72-1.96	0.50
SDQ									
Hyperactivity	**2.43**	**1.66-3.56**	**<0.01**	**2.29**	**1.47-3.55**	**<0.01**	**2.23**	**1.40-3.54**	**<0.01**
Emotional problems	0.99	0.63-1.56	0.97	0.94	0.56-1.57	0.80	0.86	0.48-1.53	0.60
Conduct problems	**1.49**	**1.03-2.15**	**0.04**	1.31	0.85-2.00	0.22	1.16	0.74-1.82	0.51
Peer problems	1.04	0.69-1.56	0.86	0.93	0.58-1.50	0.77	0.87	0.52-1.44	0.58
Use of electronic games: 5 years of age									
FTF	***OR***	***95% CI***	***p***	***OR***	***95% CI***	***p***	***OR***	***95% CI***	***p***
Attention and concentration difficulties	0.95	0.60-1.51	0.82	0.69	0.41-1.16	0.16	0.67	0.38-1.17	0.16
Hyperactivity and impulsivity	1.20	0.77-1.87	0.42	0.89	0.54-1.48	0.66	0.82	0.48-1.42	0.48
Emotional/internalizing symptoms	1.22	0.76-1.96	0.40	1.27	0.75-2.16	0.38	1.36	0.78-2.40	0.28
Emotional/externalizing symptoms	1.37	0.86-2.16	0.19	1.23	0.74-2.05	0.42	1.42	0.83-2.42	0.20
SDQ									
Hyperactivity	**1.65**	**1.08-2.51**	**0.02**	1.06	0.65-1.72	0.81	0.98	0.58-1.66	0.95
Emotional problems	0.95	0.58-1.58	0.85	1.10	0.63-1.92	0.75	1.04	0.55-1.97	0.90
Conduct problems	1.04	0.69-1.57	0.85	0.88	0.55-1.40	0.58	0.75	0.50-1.25	0.27
Peer problems	1.10	0.71-1.70	0.69	0.87	0.52-1.46	0.60	0.83	0.48-1.44	0.51

[a] Adjusted for age, gender, parent's education, screen time at 18 months of age.

[b] Adjusted for age, gender, parent's education, siblings, and daycare participation, screen time at 18 months of age.

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Preschoolers' high-dose electronic media use and its association with their psychosocial well-being at five years of age

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Abstract

Objectives This study investigated the frequency of preschooler's electronic media (e-media) usage and the risks of high-dose e-media use on young children's psychosocial well-being.

Design We study longitudinal associations between e-media use at 18 months and psychosocial symptoms at five years of age, as well as cross-sectional associations between e-media use and psychosocial symptoms at five years.

Setting Between 2011 and 2017 in Finland.

Participants Children aged 5 years (N=699).

Primary and secondary outcome measures Children's psychosocial symptoms were asked at the age of five years using the parent-reported questionnaires Five-to-Fifteen (FTF) and the Strengths and Difficulties Questionnaire (SDQ).

Results Based on our results, 95% of the preschoolers exceed the daily electronic media use recommendation set by health professionals. Our results indicate that increased screen time at five years of age is associated with a risk of multiple psychosocial symptoms (OR 1.53-2.18, 95% CI: 1.05-3.20, $p<0.05$), while increased levels of e-media use at 18 months was only associated with FTF peer problems (OR 1.59, CI: 1.04-2.41, p=0.03). Moreover, high-dose use of electronic games at the age of five years seems to be associated with fewer risks for psychosocial well-being than program viewing, as it was only associated with SDQ hyperactivity (OR 1.65, CI 1.49-3.20, p=0.02).

Conclusion Increased screen time has multiple risks for children's psychosocial well-being. These risk factors seem to be significant in the long term, and cause problems in children's socio-emotional development later on. Health professionals and pediatricians have an important role as communicators of the current research results on the safe usage time of e-media for families, and enhance parents' skills as regulators of children's safe e-media use. In the future, more research is needed on the family conditions of high-dose e-media users.

Strengths and limitations of this study

- A major strength of our study is the longitudinal study setting and repeated measurement of e-media exposure.
- Additionally, patterns of children's electronic media use are rapidly changing, and our study offers results on the associations of young children's e-media usage with their psychosocial well-being based on recent data.
- The limitation of our study is the measurement of e-media use that was based on parental questionnaires and not logs.
- Moreover, the sample is based on a representative birth cohort recruited during pregnancy. However, those with lower education seem to be underrepresented in the sample, as are single mothers.

Keywords: Child psychiatry, child psychiatric epidemiology, pediatrics, child mental health, child development, e-media

Introduction

In recent years, as digital technology has rapidly developed, electronic media (e-media) has become an almost universal part of young children's daily life. Even at preschool age, e-media use is already a popular sedentary behavior (1). Traditional e-media is often used: nearly half of preschool-age children watch TV (2), use a laptop or desktop computer, and play video consoles daily (3). However, the pattern of how media is used has changed considerably in recent years, as preschool children's use of mobile devices has tripled from 2013 to 2017, although the overall amount of e-media use has remained relatively stable (2). Recent studies also report that a large proportion (81.3%) of 4-year-old children play games, use applications, or watch videos on mobile devices daily (3).

Electronic media use (i.e. total screen time) comprises program viewing (i.e. watching of programs from TV, DVDs, mobile devices), as well as use of social media, internet and e-games. While the negative forms of e-media use (e.g., playing e-games alone), are often emphasized, the healthier forms also exist. A reasonable amount of educational electronic media material (e.g., serious games) might have beneficial effects on young children's psychosocial well-being and development (4). Moreover, e-media use involving social interactions, such as use with caregivers might be having fewer risks than the use alone, as parents can help the children to understand what they are seeing (5). Use of e-games with siblings and peers seems also to be less risky (6).

High dose use of e-media in young children can be a risk factor for the development of a child. Studies suggest that frequent e-media use in family households might interrupt parent-child interaction, which might cause problems in children's social-emotional development (1,4,7–9). Thus, high dose use of e-media can also be related to the development of a child, such as language development (10) or development of social skills (11), which are important to the children's psychosocial health. High-dose use can also develop to a behavioral addiction. While studied less among children, according to a recent study, internet- or screen-based behavioral addictions appear as a child's persistent requests to access e-media, and parents' unsuccessful attempts to control the use. It might cause problems with family members, such as parents and siblings, and lead to a loss of a child's previous hobbies and interests (12).

The World Health Organization (WHO) has published guidelines for the total screen time of children aged 2-4. The recommendation is a maximum of one hour per day for this age group (13). However, in previous studies, much higher amounts have been reported. For example, among American children aged 2-4, the average total screen time per day was 159 minutes (2), and among Finnish children aged 3-6 it was 111 min (14). It seems that parents may be unaware of the potential risks of high-dose e-media usage for their children's psychosocial well-being. Studies have even pointed out that some parents use e-media devices as a tool to calm down their children, especially when the child has social emotional difficulties (15–18). Thus, the link between e-media use and psychosocial symptoms seems to be bidirectional.

Based on the research, it seems that a high amount of program viewing is a risk for preschool-age children's psychosocial well-being (4). It is associated with externalizing problems, such as hyperactivity (8,19) and conduct problems (19–21), and also with peer problems (22). However, fewer studies have investigated the associations between electronic game-playing and preschool-age children's psychosocial well-being (6,19,23). According to these studies, it seems that electronic game-playing might be less detrimental and may even have some positive effects on children's socio-emotional skills (6). Nonetheless, the use of electronic games and computers are associated with internalizing problems, such as emotional problems (23).

As the patterns of children's electronic media usage are rapidly changing, the updated data on the degree of e-media usage and its significance on well-being is needed. Moreover, although there is evidence showing the harmful effects of preschool-age children's high-dose e-media use on their well-being, few of these studies have analyzed the longitudinal associations of early exposure of e-media to children's later psychosocial problems. According to these studies it seems that high-dose e-media use that starts at early age might be detrimental for young children's psychosocial health later on (8,19,23).

The aim of this research is to assess the amount of preschooler's e-media usage and its associations with their psychosocial well-being. We study longitudinal associations between e-media use at 18 months and psychosocial symptoms at five years of age, as well as cross-sectional associations between e-media use (program viewing and electronic game-playing) and psychosocial symptoms at five years. Psychosocial symptoms, i.e., internalizing and externalizing problems and inattention, were assessed at five years of age. We hypothesized that children who consume large amounts of e-media at 18 months of age have more psychosocial symptoms at five years than those who use less. Moreover, we hypothesized that program viewing is associated with more problems in psychosocial health, while use of e-games has less associations with negative outcomes.

Method

Study design

This study is part of a larger Finnish CHILD-SLEEP longitudinal birth cohort study, which includes several measurement points. The study design, protocol, participants, and measures have been described in more detail in Paavonen et al. (24). The recruitment and baseline measurement took place prenatally at the 32nd week and the follow-up measurements occurred at the birth of the child and at three, eight, 18, 24 and 60 months of age. Moreover, records from the maternity hospital and maternity clinics were collated. The study protocol was approved by the local Hospital District Ethical Committee (9.3.2011, ethical research permission code R11032). Permission for the recruitment procedure was also received from the leading doctors of the targeted health centers. Participants were also asked to give their written informed consent. Participation to the study was voluntary, and the families received no compensation for the participation.

Participants

Mothers and fathers were recruited for the study in the Pirkanmaa Hospital District area in Southern Finland. Altogether, 2244 parents gave their approval to receive prenatal questionnaires when they visited the maternity clinics, and 1679 (74.8%) of them gave their consent to participate in the study and returned the baseline questionnaires. The response rate at 5 years of age was 42.5% (N=714). Children with severe chronic illnesses or disabilities, e.g., Down's syndrome or Hirschsprung disease (n=7), and all twins (n=8) were excluded. The final sample included 699 children whose parents had answered the Strengths and Difficulties Questionnaire (SDQ) (25) or the Five-to-Fifteen (FTF) (26) questionnaire at the children's age of 5 years. The questionnaire at 5 years of age included SDQ and e-media usage questions and was answered by the parents of 653 children. The FTF questionnaire was answered by the parents of 668 children. In addition, the 18-months questionnaire, which included children's media usage questions at that age, was available for 585 (out of 699) children. The 18-months questionnaire did not include measures of children's psychosocial symptoms. Information concerning parental sociodemographic factors such as education and number of previous children were asked prenatally and they were available for 641 children.

Patient and public Involvement

Patients or the public were not involved in the design, or conduct, or reporting of the research.

Measures

Screen time

Parents reported the time a child spent engaging in electronic media activities at both 18 months and 5 years of age. Separate questions were asked for weekday and weekend e-media use on how many hours a child watches programs (including on television or other devices), and (at 5 years) how many hours a child participates in electronic game-playing (on a computer, console devices, cell phones, tablets, or other devices). Questions on electronic game-playing at 18 months were not included as their use in this age-group became more common only after our data has collected (2).

For the analyses, we first recoded all the reported electronic media use measures into minutes. Second, we calculated a weighted daily average (5/7 on weekdays and 2/7 at weekends) of the measures. At 18 months the daily average for program viewing ranged from 0 to 253 minutes. At 5 years, separate measures for program viewing (range 225) and game-playing (range 182) were calculated, as well as the total screen time per day, by totaling both electronic media use measures (range 321). Finally, each of the electronic-media use measures (program viewing, game-playing, total screen time) was dichotomized using a 75 percentile cut-off to indicate those with the highest dose of e-media use: Program viewing at 18 months of age $\geq$ 46 mins per day (24.4%, n=143), program viewing at 5 years of age $\geq$ 88 mins per day (24.3%, n=161), use of electronic games at 5 years of age $\geq$ 45 mins per day (19.3%, n=126), total screen time at 5 years of age $\geq$ 135 mins per day (24.6%, n=160).

Outcomes (5 years of age)

Children's psychosocial symptoms were asked at the age of five years using two different parent-reported questionnaires: the FTF and the SDQ. From these questionnaires subscales most directly linked to the concept of psychosocial symptoms, i.e., emotional and behavioral problems and inattention, were included.

The FTF questionnaire is tested for its validity and reliability for the identification of internalizing and externalizing symptoms in children aged five to fifteen years (26,27). The items are categorized into eight different domains and 22 subdomains, of which we used the following four subdomains: Attention and concentration difficulties, hyperactivity and impulsivity, emotional internalizing problems, and emotional externalizing problems (28).

The SDQ children's questionnaire includes 25 items and five scales, with five items in each. It is a validated instrument to detect psychosocial problems in preschool-aged children (25), and is widely used for research purposes (19,23). In this research, we used four subscales: Hyperactivity, emotional problems, conduct problems, and peer problems.

Children scoring in the 75th percentile or over in SDQ and FTF subscales were considered to have clinically elevated levels of psychosocial symptoms. The cut-off points for the FTF scales sum scores were: Attention and concentration problems ≥ 6 (26%, n=172), hyperactivity and impulsivity ≥ 6 (27.9%, n=185), emotional internalizing problems ≥ 2 (22.3%, n=152), and emotional externalizing problems ≥ 4 (22.9%, n=152). Accordingly, the cut-off points for the SDQ scale sum scores were: Inattention-hyperactivity ≥ 5 (25.7%, n=171), emotional problems ≥ 2 (18.6%, n=124), conduct problems ≥ 3 (32.8%, n=218), and peer problems ≥ 3 (25.1%, n=167).

Covariates

We used child's age (years, continuous), gender, number of siblings, participation in a full-time daycare (no vs. yes), and parent's education (university vs. less) as covariates that were adjusted in the statistical analyses.

Statistical analyses

Data was analyzed using IBM SPSS statistics version 25. Frequencies of categorical/dichotomous variables as well as means and standard deviations of the continuous study variables were calculated first (see tables 1 and 2). Then, logistic regression analyses were conducted to calculate odds ratios and their 95% confidences intervals for the associations between electronic media use and outcomes. First longitudinal associations between e-media use at 18 months and FTF and SDQ scales at five years were analyzed (upper part of table 3). Then cross-sectional associations between e-media use and each of the subscales of FTF and SDQ at five years were analyzed (lower part of table 3 and table 4). In addition to the bivariate (crude) analyses, two adjusted logistic regression models were conducted: In the first model, the child's age, gender, parents' education and screen use at 18 months of age (in the analyses at five years), and in the second, fully adjusted model, the number of siblings and information on full-time daycare participation were also added to the model.

Results

Descriptive statistics of the sample are presented in **Table 1**. The mean age of the children in the sample was 5.7 years (SD=0.5). The sample consisted of 333 girls (n=47.6%) and 366 boys (52.4%). The majority of the children (67.7%) were in full-time daycare. Most of the parents (63.4%) had a university-level degree.

On average, at 18 months of age, children spent 32.4 (SD 31.0) minutes per day with electronic media devices. At five years the amount was 114.1 minutes (SD 50.6) per day (range 321). Program viewing (mean 80.4, SD 36.3) was more popular than the use of electronic games (mean 33.4, SD 25.9).

At 18 months, 22.7% of the children spent over 60 minutes consuming screen media each day, while at 5 years of age the percentage was 94.6%. Moreover, 66.8% of the children viewed programs for more than 60 minutes per day, whereas 10.6% of the children spent more than 60 minutes per day using electronic games.

The sample was generally normative, with low levels of emotional and behavioral symptoms. The mean scores for each of the subscales of psychosocial problems based on SDQ and FTF scales are reported in **Table 2**.

Table 3 reports the odds ratios for the associations between electronic media use at 18 months and five years of age on each of the subscales of FTF and SDQ. Based on the results, electronic media use at 18 months had less of a negative effect than at five years of age: A high amount of screen time at 18 months was associated with an increased risk of SDQ peer problems (OR 1.59, p=0.03). The association was significant after children's age, gender, and parent's SES were adjusted (OR 1.64, p=0.03). There was no increased risk of psychosocial problems with other subscales of FTF and SDQ.

In contrast, elevated levels of total screen time at five years of age were associated with multiple psychosocial problems: FTF attention and concentration difficulties (OR 1.88, p<0.01), hyperactivity and impulsivity (OR 1.57, p=0.03), internalizing symptoms (OR 1.75, p=0.01), and externalizing symptoms (OR 1.69, p=0.01). Moreover, it was associated with SDQ hyperactivity (OR 2.18, p<0.01) and conduct problems (OR 1.53, p=0.03). After fully controlling for the confounding factors, there were no other significant associations than the increased risk of FTF internalizing symptoms (OR 2.01, p=0.01).

Table 4 presents the odds ratios for the associations between program viewing and the use of electronic games on each of the subscales of FTF and SDQ among children at five years of age. A high amount of program viewing was associated with an increased risk of psychosocial problems, while the use of electronic games seemed less problematic. Program viewing at five years of age had an association with all of the FTF subscales (OR 1.64-1.98, p<0.05) and with SDQ hyperactivity (OR 2.43, p<0.01) and conduct problems (OR 1.48, p=0.04). In the fully-adjusted

model, an increased risk appeared for attention and concentration difficulties (OR 1.91, p=0.01) and hyperactivity and impulsivity (OR 1.67, p=0.03), and with SDQ hyperactivity (OR 2.23, p<0.01). In contrast, the use of electronic games was associated with an increased risk of SDQ hyperactivity (OR 1.65, p=0.02) and only in the unadjusted model, while with the other subscales no increased risk appeared.

Discussion

The aim of this study was to investigate the frequency of preschooler's e-media usage and the risks of high-dose e-media use on young children's psychosocial well-being. The results of our study show that 95% of preschoolers exceed the daily electronic media use recommendation of one hour, which is set by health professionals and pediatricians. Based on our results, increased screen time at five years of age was associated with a risk of multiple psychosocial symptoms, while increased levels of e-media use at 18 months had only few longitudinal associations for psychosocial symptoms at five years of age. Furthermore, high-dose use of electronic games at the age of five years seemed to be associated with fewer risks of psychosocial well-being than program viewing.

Based on the results of this study, preschoolers' average daily screen time is 114 minutes at five years of age. This number is almost two times higher than the recommended daily maximum amount of e-media, which is 60 minutes (5,13). Previous studies on preschoolers' e-media use conducted in Finland have reported similar results, as the total daily screen time was 111 minutes in 2017 (14), while in Belgium it was 81 minutes (29) in 2018. Among American children, the total screen time in 2017 in this age group was somewhat higher: 159 minutes (2). It has been suggested that the products and usage culture of electronic media develops very rapidly in United States (2,30), whereas access to products might occur at a slower pace in other countries. This might explain why the frequency of usage among young children in the US is higher than in Europe.

We discovered that high screen use at 5 years of age was associated with a risk of multiple psychosocial problems. More precisely, elevated levels of total screen time were associated with attention and concentration difficulties, hyperactivity and impulsivity, emotional internalizing and externalizing symptoms, and conduct problems. Similar results have been recently reported on emotional symptoms (19,20,23), conduct problems, and hyperactivity (20). Regarding hyperactivity, previous studies suggest that screen time may hinder the availability for activities that are considered to enhance cognitive capacities and stimulate longer attention span (31). Moreover, the harmful effect of television viewing might function by displacing developmentally important learning opportunities with an attention-capturing stimulus with a lack of developmental value (9,32). Previous studies have also reported associations between increased total screen time and peer problems (20). We did not find such associations at five years. This difference might be explained by the age of the participants: In the study of Wu et al. (2017) the mean age of the participants was 4.37, whereas in our study it was 5.68. In line with this, our findings show that screen time at an earlier age, i.e., at 18 months, was associated with peer problems later on. It seems that a high amount of screen use at a younger age is a risk factor for peer problems. However, unlike some other studies (8,19,23) we did not find high-dose use of electronic devices at 18 months of age to be associated with other problems in psychosocial well-being later on. It is possible that

parents regulate younger children's e-media usage habits, while later on, other factors may have a more important role in the amount of usage. These are for example certain inherited temperamental traits of a child, such as persistence and introversion (33), or their participation in daycare.

Our results show that an increased amount of program viewing at 5 years of age is associated with a risk of several psychosocial problems, while electronic game use had fewer associations, which is also consistent with recent previous studies (6,19,23). Electronic game-playing was only associated with SDQ hyperactivity, whereas no risks were found regarding other psychosocial symptoms. Previous studies have yielded an association between electronic game-playing and emotional symptoms. However, the direction of the association is contradictory: Increased e-game use has been associated with emotional problems (23), but also with better socio-emotional skills (6). The few associations between socioemotional health and game-playing might be explained by the social nature of game-playing: Children often participate in the use of e-games with siblings and other family members, for example, and develop their social and emotional skills in these social interactions (6). All in all, the amount of daily e-game usage in our study and all of these other studies was much lower compared to program viewing, which might explain why e-games are not associated with psychosocial problems to any larger extent at this age.

As our results point out, increased screen time has multiple risks for children's psychosocial well-being. These risk factors might accumulate in the long-term, and cause problems in children's socio-emotional development later on. Health professionals and pediatricians play an important role as communicators of the current research results on the safe usage of e-media for families. Parents' knowledge might further help them to set safe boundaries for young children's e-media use and protect children's psychosocial health from associated risk factors (34).

One possible mechanism accounting for the result might be that the time children spend on e-media reduces the time spend on constructive activities, such as interactions with family members, reading and playing (1,4,7). At an early age, children's socio-emotional development occurs in a dynamic interplay between social learning and environmental factors. Furthermore, if the surrounding environment does not offer enough means for a child's healthy development, it might affect a children's psychosocial well-being (35). Genetic dispositions also play a role in modifying individual risks. However, the direction of the effect of e-media use is unclear, as some parents might use e-media devices as a tool to calm their children down, especially when the child has socio-emotional difficulties (15). It is possible, that there is a bidirectional link between the two factors.

One strength of our study is its longitudinal study setting and its repeated measurement of e-media exposure. Moreover, patterns of children's electronic media usage are rapidly changing, and our study offers results on the associations between young children's e-media use and their psychosocial well-being based on recent data. In addition, the sample is based on a representative birth cohort recruited during pregnancy.

A limitation of our study is that those with lower education seem to be underrepresented in the sample, which is common according to studies on drop-out rates in longitudinal studies on mental

health (36). Moreover, single mothers are underrepresented in the sample. Another limitation is that psychological symptoms at 18 months of age were not assessed. The measurement of e-media use was based on parental questionnaires and not logs. However, in a previous study (14) conducted in Finland among a comparable age-group and using parental logs on child's e-media use, the reported daily total e-media exposure was 111 minutes, while in our study the respective figure was 114 minutes. This suggests that the reported exposures in our study could be relatively reliable. Nevertheless, in future studies, parent reports of children's e-media use need to be validated with objective measures. In the future, more research is needed on the family conditions of high-dose e-media users.

Conclusion

This study reported the risks associated with high-dose use of electronic media devices by young children. Our results show that 5-year-old children spend considerably more time on e-media than is recommended by professionals. Our results further indicate that high levels of e-media use, especially program viewing, is associated with problems with psychosocial outcomes, while e-games play a lesser role among five-year-olds. Children's social-emotional development is influenced by environmental factors, including electronic media habits. Although children's electronic media use patterns might not seem problematic when considering use on a daily level, they do have risks in the long term. Thus, health professionals play a key role in providing information for parents on screen media parenting, i.e., the safe use of e-media devices among young children in order to protect their healthy development.

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Contributorship statement

EJP and OSH designed the study. JN, OK, and EJP were primarily responsible for data analysis and writing of the article. RV and OSH contributed critically to the writing of the article.

Competing interests

The authors declare no competing interests.

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Data sharing statement

Data is not publicly available due to legal restrictions and confidential nature of the data. Data is available upon request. Requests may be sent to The Finnish Institute for Health and Welfare, who is the controller of the data. For more information about data access, please see https://thl.fi/en/web/thlfi-en/statistics/information-for-researchers.

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Table 1. Descriptive statistics of sociodemographic factors and measures of screen time (N=699)

	% (N)
Sociodemographic factors	
Child's gender	
Girls	47.6 (333)
Boys	52.4 (366)
Child's age, years; mean (SD)	5.68 (0.54)
Parent's education	
University-level degree	63.4 (409)
Less than university-level degree	36.6 (236)
Number of siblings	
0	51.0 (327)
1	32.2 (207)
2	12.9 (83)
3	2.5 (16)
4 or more	1.2 (8)
Full-time daycare	
No	32.3 (214)
Yes	67.7 (448)
Screen time	
Total screen time at 18 months, min; mean (SD), range	32.4 (31.0), 252.9
Over 60 minutes, %	22.7 (136)
Over 120 minutes, %	2.8 (17)
Program viewing at 5 years, min; mean (SD), range	80.4 (36.3), 225.0
Over 60 minutes, %	66.8 (442)
Over 120 minutes, %	16.9 (112)
Electronic game-playing at 5 years, min; mean (SD), range	33.4 (25.9), 182.1
Over 60 minutes, %	10.6 (69)
Over 120 minutes, %	2.3 (15)
Total screen time at 5 years, min; mean (SD), range	114.1 (50.6), 321.4
Over 60 minutes, %	94.6 (615)
Over 120 minutes, %	40.2 (261)
Over 180 minutes, %	11.5 (75)

Table 2. Outcome variables.

Outcome variable	Mean (SD)	Range
FTF		
Attention and concentration difficulties	3.75 (3.41)	18.00
Hyperactivity and impulsivity	3.98 (3.63)	18.00
Emotional/internalizing symptoms	1.52 (1.79)	15.00
Emotional/externalizing symptoms	2.83 (3.25)	21.00
SDQ		
Hyperactivity	3.04 (2.34)	10.00
Emotional problems	1.38 (1.48)	9.00
Conduct problems	1.97 (1.59)	9.00
Peer problems	1.69 (1.38)	9.00

Table 3. Associations between electronic media use at 18 months and 5 years of age with psychosocial well-being at age 5 years.

Screen time: 18 months of age	***Crude***			***Adjusted 1*** [a]			***Adjusted 2*** [b]		
FTF	***OR***	***95% CI***	***p***	***OR***	***95% CI***	***p***	***OR***	***95% CI***	***p***
Attention and concentration difficulties	1.46	0.96-2.22	0.07	1.50	0.97-2.31	0.07	1.41	0.89-2.22	0.14
Hyperactivity and impulsivity	1.16	0.76-1.77	0.50	1.16	0.75-1.81	0.50	1.14	0.72-1.80	0.59
Emotional/internalizing symptoms	1.19	0.76-1.88	0.45	1.15	0.72-1.85	0.55	1.13	0.69-1.86	0.62
Emotional/externalizing symptoms	1.03	0.66-1.60	0.91	1.04	0.65-1.65	0.88	1.06	0.65-1.72	0.82
SDQ									
Hyperactivity	1.49	0.98-2.26	0.06	1.37	0.89-2.12	0.15	1.37	0.87-2.18	0.18
Emotional problems	1.36	0.86-2.17	0.19	1.38	0.85-2.23	0.19	1.47	0.88-2.45	0.14
Conduct problems	1.24	0.84-1.84	0.28	1.26	0.84-1.90	0.27	1.23	0.80-1.90	0.35
Peer problems	**1.59**	**1.04-2.41**	**0.03**	**1.64**	**1.06-2.52**	**0.03**	1.56	0.98-2.46	0.06
Total screen time: 5 years of age									
FTF	***OR***	***95% CI***	***p***	***OR***	***95% CI***	***p***	***OR***	***95% CI***	***p***
Attention and concentration difficulties	**1.88**	**1.27-2.80**	**<0.01**	1.45	0.92-2.28	0.11	1.57	0.97-2.53	0.07
Hyperactivity and impulsivity	**1.57**	**1.06-2.33**	**0.03**	1.33	0.85-2.12	0.22	1.31	0.81-2.13	0.28
Emotional/internalizing symptoms	**1.75**	**1.15-2.65**	**0.01**	**1.84**	**1.14-2.97**	**0.01**	**2.01**	**1.21-3.34**	**0.01**
Emotional/externalizing symptoms	**1.69**	**1.12-2.55**	**0.01**	1.39	0.87-2.23	0.17	1.54	0.94-2.52	0.09
SDQ									
Hyperactivity	**2.18**	**1.49-3.20**	**<0.01**	**1.60**	**1.02-2.49**	**0.04**	1.55	0.97-2.48	0.07
Emotional problems	0.99	0.62-1.56	0.95	0.98	0.58-1.66	0.94	0.90	0.49-1.61	0.70
Conduct problems	**1.53**	**1.05-2.21**	**0.03**	1.24	0.81-1.91	0.32	1.06	0.67-1.67	0.80
Peer problems	1.06	0.71-1.60	0.77	0.90	0.56-1.45	0.67	0.85	0.51-1.42	0.53

[a] Adjusted for age, gender, parent's education. Total screen time at 5 years of age: Also adjusted for screen time at 18 months of age.

[b] Adjusted for age, gender, parent's education, number of siblings, and daycare participation. Total screen time at 5 years of age: Also adjusted for screen time at 18 months of age.

Table 4. Associations between program viewing and use of electronic games at 5 years of age with psychosocial well-being.

Program viewing: 5 years of age	***Crude***			***Adjusted 1*** [a]			***Adjusted 2*** [b]		
FTF	***OR***	***95% CI***	***p***	***OR***	***95% CI***	***p***	***OR***	***95% CI***	***p***
Attention and concentration difficulties	**1.98**	**1.34-2.93**	**<0.01**	**1.71**	**1.10-2.69**	**0.02**	**1.91**	**1.19-3.08**	**0.01**
Hyperactivity and impulsivity	**1.64**	**1.11-2.42**	**0.01**	**1.68**	**1.07-2.63**	**0.02**	**1.67**	**1.04-2.69**	**0.03**
Emotional/internalizing symptoms	**1.68**	**1.11-2.54**	**0.01**	1.59	0.99-2.55	0.06	**1.71**	**1.03-2.84**	**0.04**
Emotional/externalizing symptoms	**1.69**	**1.12-2.55**	**0.01**	1.14	0.71-1.84	0.59	1.19	0.72-1.96	0.50
SDQ									
Hyperactivity	**2.43**	**1.66-3.56**	**<0.01**	**2.29**	**1.47-3.55**	**<0.01**	**2.23**	**1.40-3.54**	**<0.01**
Emotional problems	0.99	0.63-1.56	0.97	0.94	0.56-1.57	0.80	0.86	0.48-1.53	0.60
Conduct problems	**1.49**	**1.03-2.15**	**0.04**	1.31	0.85-2.00	0.22	1.16	0.74-1.82	0.51
Peer problems	1.04	0.69-1.56	0.86	0.93	0.58-1.50	0.77	0.87	0.52-1.44	0.58
Use of electronic games: 5 years of age									
FTF	***OR***	***95% CI***	***p***	***OR***	***95% CI***	***p***	***OR***	***95% CI***	***p***
Attention and concentration difficulties	0.95	0.60-1.51	0.82	0.69	0.41-1.16	0.16	0.67	0.38-1.17	0.16
Hyperactivity and impulsivity	1.20	0.77-1.87	0.42	0.89	0.54-1.48	0.66	0.82	0.48-1.42	0.48
Emotional/internalizing symptoms	1.22	0.76-1.96	0.40	1.27	0.75-2.16	0.38	1.36	0.78-2.40	0.28
Emotional/externalizing symptoms	1.37	0.86-2.16	0.19	1.23	0.74-2.05	0.42	1.42	0.83-2.42	0.20
SDQ									
Hyperactivity	**1.65**	**1.08-2.51**	**0.02**	1.06	0.65-1.72	0.81	0.98	0.58-1.66	0.95
Emotional problems	0.95	0.58-1.58	0.85	1.10	0.63-1.92	0.75	1.04	0.55-1.97	0.90
Conduct problems	1.04	0.69-1.57	0.85	0.88	0.55-1.40	0.58	0.75	0.50-1.25	0.27
Peer problems	1.10	0.71-1.70	0.69	0.87	0.52-1.46	0.60	0.83	0.48-1.44	0.51

[a] Adjusted for age, gender, parent's education, screen time at 18 months of age.

[b] Adjusted for age, gender, parent's education, siblings, and daycare participation, screen time at 18 months of age.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Abstract page
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	1-2
Objectives	3	State specific objectives, including any prespecified hypotheses	2
Methods			
Study design	4	Present key elements of study design early in the paper	2-3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	2-3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	3
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	3-4
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	3-4
Bias	9	Describe any efforts to address potential sources of bias	8
Study size	10	Explain how the study size was arrived at	3
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	3-4
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	4-5
		(*b*) Describe any methods used to examine subgroups and interactions	-
		(*c*) Explain how missing data were addressed	3
		(*d*) If applicable, explain how loss to follow-up was addressed	
		(*e*) Describe any sensitivity analyses	-

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	3-4
		(b) Give reasons for non-participation at each stage	3-4
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	4-5
		(b) Indicate number of participants with missing data for each variable of interest	4
		(c) Summarise follow-up time (eg, average and total amount)	4-5
Outcome data	15*	Report numbers of outcome events or summary measures over time	Table 2
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Tables 3 and 4
		(*b*) Report category boundaries when continuous variables were categorized	3-4
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	6
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8
Generalisability	21	Discuss the generalisability (external validity) of the study results	8
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	9

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

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High-dose electronic media use in five-year-olds and its association with their psychosocial symptoms – a cohort study

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High-dose electronic media use in five-year-olds and its association with their psychosocial symptoms – a cohort study

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Abstract

Objectives This study investigated the frequency of preschooler's electronic media (e-media) usage and the risks of high-dose e-media use on young children's psychosocial well-being.

Design We study longitudinal associations between e-media use at 18 months and psychosocial symptoms at five years of age, as well as cross-sectional associations between e-media use and psychosocial symptoms at five years.

Setting Between 2011 and 2017 in Finland.

Participants Children aged 5 years (N=699).

Primary and secondary outcome measures Children's psychosocial symptoms were asked at the age of five years using the parent-reported questionnaires Five-to-Fifteen (FTF) and the Strengths and Difficulties Questionnaire (SDQ).

Results Based on our results, 95% of the preschoolers exceed the daily electronic media use recommendation set by health professionals. Our results indicate that increased screen time at five years of age is associated with a risk of multiple psychosocial symptoms (OR=1.53-2.18, 95% CI: 1.05-3.20, $p<0.05$), while increased levels of e-media use at 18 months was only associated with FTF peer problems (OR=1.59, CI: 1.04-2.41, $p=0.03$). Moreover, high-dose use of electronic games at the age of five years seems to be associated with fewer risks for psychosocial well-being than program viewing, as it was only associated with SDQ hyperactivity (OR=1.65, CI: 1.49-3.20, $p=0.02$).

Conclusion Increased screen time has multiple risks for children's psychosocial well-being. These risk factors seem to be significant in the long term, and are related to problems in children's socio-emotional development later on. Health professionals and pediatricians have an important role as communicators of the current research results on the safe usage time of e-media for families, and enhance parents' skills as regulators of children's safe e-media use. In the future, more research is needed on the family conditions of high-dose e-media users.

Strengths and limitations of this study

- A major strength of our study is the longitudinal study setting and repeated measurement of e-media exposure.
- Additionally, patterns of children's electronic media use are rapidly changing, and our study offers results on the associations of young children's e-media usage with their psychosocial well-being based on recent data.
- The limitation of our study is the measurement of e-media use that was based on parental questionnaires and not logs.
- Moreover, the sample is based on a representative birth cohort recruited during pregnancy.
- However, single mothers as well as those with lower education seem to be underrepresented in the sample.

Keywords: Child psychiatry, child psychiatric epidemiology, pediatrics, child mental health, child development, e-media

Introduction

In recent years, as digital technology has rapidly developed, electronic media (e-media) has become an almost universal part of young children's daily life. Even at preschool age, e-media use is already a popular sedentary behavior (1). Traditional e-media is often used: nearly half of preschool-age children watch TV (2), use a laptop or desktop computer, and play video consoles daily (3). However, the pattern of how media is used has changed considerably in recent years, as preschool children's use of mobile devices has tripled from 2013 to 2017, although the overall amount of e-media use has remained relatively stable (2). Recent studies also report that a large proportion (81.3%) of 4-year-old children play games, use applications, or watch videos on mobile devices daily (3).

Electronic media use (i.e. total screen time) comprises program viewing (i.e. watching of programs from TV, DVDs, mobile devices), as well as use of social media, internet and e-games. While the negative forms of e-media use (e.g., playing e-games alone), are often emphasized, the healthier forms also exist. A reasonable amount of educational electronic media material (e.g., serious games) might have beneficial effects on young children's psychosocial well-being and development (4). Moreover, e-media use involving social interactions, such as use with caregivers might be having fewer risks than the use alone, as parents can help the children to understand what they are seeing (5). Use of e-games with siblings and peers seems also to be less risky (6).

High dose use of e-media in young children can be a risk factor for the development of a child. Studies suggest that frequent e-media use in family households might interrupt parent-child interaction, which might cause problems in children's social-emotional development (1,4,7–9). Thus, high dose use of e-media can also be related to the development of a child, such as language development (10) or development of social skills (11), which are important to the children's psychosocial health. High-dose use can also develop to a behavioral addiction. While studied less among children, according to a recent study, internet- or screen-based behavioral addictions appear as a child's persistent requests to access e-media, and parents' unsuccessful attempts to control the use. It might cause problems with family members, such as parents and siblings, and lead to a loss of a child's previous hobbies and interests (12).

The World Health Organization (WHO) has published guidelines for the total screen time of children aged 2-4. The recommendation is a maximum of one hour per day for this age group (13). However, in previous studies, much higher amounts have been reported. For example, among American children aged 2-4, the average total screen time per day was 159 minutes (2), and among Finnish children aged 3-6 it was 111 min (14). It seems that parents may be unaware of the potential risks of high-dose e-media usage for their children's psychosocial well-being. Studies have even pointed out that some parents use e-media devices as a tool to calm down their children, especially when the child has social emotional difficulties (15–18). Thus, the link between e-media use and psychosocial symptoms seems to be bidirectional.

Based on the research, it seems that a high amount of program viewing is a risk for preschool-age children's psychosocial well-being (4). It is associated with externalizing problems, such as

hyperactivity (8,19) and conduct problems (19–21), and also with peer problems (22). However, fewer studies have investigated the associations between electronic game-playing and preschool-age children's psychosocial well-being (6,19,23). According to these studies, it seems that electronic game-playing might be less detrimental and may even have some positive effects on children's socio-emotional skills (6). Nonetheless, the use of electronic games and computers are associated with internalizing problems, such as emotional problems (23).

As the patterns of children's electronic media usage are rapidly changing, the updated data on the degree of e-media usage and its significance on well-being is needed. Moreover, although there is evidence showing the harmful effects of preschool-age children's high-dose e-media use on their well-being, few of these studies have analyzed the longitudinal associations of early exposure of e-media to children's later psychosocial problems. According to these studies it seems that high-dose e-media use that starts at early age might be detrimental for young children's psychosocial health later on (8,19,23).

The aim of this research is to assess the amount of preschooler's e-media usage and its associations with their psychosocial well-being. We study longitudinal associations between e-media use at 18 months and psychosocial symptoms at five years of age, as well as cross-sectional associations between e-media use (program viewing and electronic game-playing) and psychosocial symptoms at five years. Psychosocial symptoms, i.e., internalizing and externalizing problems and inattention, were assessed at five years of age. We hypothesized that children who consume large amounts of e-media at 18 months of age have more psychosocial symptoms at five years than those who use less. Moreover, we hypothesized that program viewing is associated with more problems in psychosocial health, while use of e-games has less associations with negative outcomes.

Method

Study design

This study is part of a larger Finnish CHILD-SLEEP longitudinal birth cohort study, which includes several measurement points. The study design, protocol, participants, and measures have been described in more detail in Paavonen et al. (24). The recruitment and baseline measurement took place prenatally at the 32nd week and the follow-up measurements occurred at the birth of the child and at three, eight, 18, 24 and 60 months of age. Moreover, records from the maternity hospital and maternity clinics were collated. The study protocol was approved by the local Hospital District Ethical Committee (9.3.2011, ethical research permission code R11032). Permission for the recruitment procedure was also received from the leading doctors of the targeted health centers. Participants were also asked to give their written informed consent. Participation to the study was voluntary, and the families received no compensation for the participation.

Participants

Mothers and fathers were recruited for the study in the Pirkanmaa Hospital District area in Southern Finland. Altogether, 2244 parents gave their approval to receive prenatal questionnaires when they

visited the maternity clinics, and 1679 (74.8%) of them gave their consent to participate in the study and returned the baseline questionnaires. The response rate at 5 years of age was 42.5% (N=714). Children with severe chronic illnesses or disabilities, e.g., Down's syndrome or Hirschsprung disease (n=7), and all twins (n=8) were excluded. The final sample included 699 children whose parents had answered the Strengths and Difficulties Questionnaire (SDQ) (25) or the Five-to-Fifteen (FTF) (26) questionnaire at the children's age of 5 years. The questions regarding child were asked from both parents at five years and 73.4% the answers was filled by a mother alone, 1.0% by father alone and 25.5% by parents together. The questionnaire at 5 years of age included SDQ and e-media usage questions and was answered by the parents of 653 children. The FTF questionnaire was answered by the parents of 668 children. In addition, the 18-months questionnaire, which included children's media usage questions at that age, was available for 585 (out of 699) children. The 18-months questionnaire did not include measures of children's psychosocial symptoms. Information concerning maternal sociodemographic factors such as education and number of previous children were asked prenatally and they were available for 641 children.

Patient and public Involvement

Patients or the public were not involved in the design, or conduct, or reporting of the research.

Measures

Screen time

Parents reported the time a child spent engaging in electronic media activities at both 18 months and 5 years of age. Separate questions were asked for weekday and weekend e-media use on how many hours a child watches programs (including on television or other devices), and (at 5 years) how many hours a child participates in electronic game-playing (on a computer, console devices, cell phones, tablets, or other devices). Questions on electronic game-playing at 18 months were not included as their use in this age-group became more common only after our data has collected (2).

For the analyses, we first recoded all the reported electronic media use measures into minutes. Second, we calculated a weighted daily average (5/7 on weekdays and 2/7 at weekends) of the measures. At 18 months the daily average for program viewing ranged from 0 to 253 minutes. At 5 years, separate measures for program viewing (range 225) and game-playing (range 182) were calculated, as well as the total screen time per day, by totaling both electronic media use measures (range 321). Finally, each of the electronic-media use measures (program viewing, game-playing, total screen time) was dichotomized using a 75 percentile cut-off to indicate those with the highest dose of e-media use: Program viewing at 18 months of age ≥ 46 mins per day (24.4%, n=143), program viewing at 5 years of age ≥ 88 mins per day (24.3%, n=161), use of electronic games at 5 years of age ≥ 45 mins per day (19.3%, n=126), total screen time at 5 years of age ≥ 135 mins per day (24.6%, n=160).

Outcomes (5 years of age)

Children's psychosocial symptoms were asked at the age of five years using two different parent-reported questionnaires: the FTF and the SDQ. From these questionnaires subscales most directly linked to the concept of psychosocial symptoms, i.e., emotional and behavioral problems and inattention, were included.

The FTF questionnaire is tested for its validity and reliability for the identification of internalizing and externalizing symptoms in children aged five to fifteen years (26,27). The items are categorized into eight different domains and 22 subdomains, of which we used the following four subdomains: Attention and concentration difficulties, hyperactivity and impulsivity, emotional internalizing problems, and emotional externalizing problems (28).

The SDQ children's questionnaire includes 25 items and five scales, with five items in each. It is a validated instrument to detect psychosocial problems in preschool-aged children (25), and is widely used for research purposes (19,23). In this research, we used four subscales: Hyperactivity, emotional problems, conduct problems, and peer problems.

Children scoring in the 75th percentile or over in SDQ and FTF subscales were considered to have clinically elevated levels of psychosocial symptoms. The cut-off points for the FTF scales sum scores were: Attention and concentration problems ≥ 6 (26%, n=172), hyperactivity and impulsivity ≥ 6 (27.9%, n=185), emotional internalizing problems ≥ 2 (22.3%, n=152), and emotional externalizing problems ≥ 4 (22.9%, n=152). Accordingly, the cut-off points for the SDQ scale sum scores were: Inattention-hyperactivity ≥ 5 (25.7%, n=171), emotional problems ≥ 2 (18.6%, n=124), conduct problems ≥ 3 (32.8%, n=218), and peer problems ≥ 3 (25.1%, n=167).

Covariates

We used child's age (years, continuous), gender, number of siblings, participation in a full-time daycare (no vs. yes), and maternal education (university vs. less) as covariates that were adjusted in the statistical analyses.

Statistical analyses

Data was analyzed using IBM SPSS statistics version 25. Frequencies of categorical/dichotomous variables as well as means and standard deviations of the continuous study variables were calculated first (see tables 1 and 2). Then, logistic regression analyses were conducted to calculate odds ratios and their 95% confidences intervals for the associations between electronic media use and outcomes. First longitudinal associations between e-media use at 18 months and FTF and SDQ scales at five years were analyzed (upper part of table 3). Then cross-sectional associations between e-media use and each of the subscales of FTF and SDQ at five years were analyzed (lower part of table 3 and table 4). In addition to the bivariate (crude) analyses, two adjusted logistic regression models were conducted: In the first model, the child's age, gender, maternal education and screen use at 18 months of age (in the analyses at five years), and in the second, fully adjusted model, the number of siblings and information on full-time daycare participation were also added to the model.

Results

Descriptive statistics of the sample are presented in **Table 1**. The mean age of the children in the sample was 5.7 years (SD=0.5). The sample consisted of 333 girls (n=47.6%) and 366 boys (52.4%). The majority of the children (67.7%) were in full-time daycare. Most of the parents (63.4%) had a university-level degree.

On average, at 18 months of age, children spent 32.4 (SD 31.0) minutes per day with electronic media devices. At five years the amount was 114.1 minutes (SD 50.6) per day (range 321). Program viewing (mean 80.4, SD 36.3) was more popular than the use of electronic games (mean 33.4, SD 25.9).

At 18 months, 22.7% of the children spent over 60 minutes consuming screen media each day, while at 5 years of age the percentage was 94.6%. Moreover, 66.8% of the children viewed programs for more than 60 minutes per day, whereas 10.6% of the children spent more than 60 minutes per day using electronic games.

The sample was generally normative, with low levels of emotional and behavioral symptoms. The mean scores for each of the subscales of psychosocial problems based on SDQ and FTF scales are reported in **Table 2**.

Table 3 reports the odds ratios for the associations between electronic media use at 18 months and five years of age on each of the subscales of FTF and SDQ. Based on the results, electronic media use at 18 months had less of a negative effect than at five years of age: A high amount of screen time at 18 months was associated with an increased risk of SDQ peer problems (OR=1.59, p=0.03). The association was significant after children's age, gender, and parent's SES were adjusted (OR=1.64, p=0.03). There was no increased risk of psychosocial problems with other subscales of FTF and SDQ.

In contrast, elevated levels of total screen time at five years of age were associated with multiple psychosocial problems: FTF attention and concentration difficulties (OR=1.88, p<0.01), hyperactivity and impulsivity (OR=1.57, p=0.03), internalizing symptoms (OR=1.75, p=0.01), and externalizing symptoms (OR=1.69, p=0.01). Moreover, it was associated with SDQ hyperactivity (OR=2.18, p<0.01) and conduct problems (OR 1.53, p=0.03). After fully controlling for the confounding factors, there were no other significant associations than the increased risk of FTF internalizing symptoms (OR=2.01, p=0.01).

Table 4 presents the odds ratios for the associations between program viewing and the use of electronic games on each of the subscales of FTF and SDQ among children at five years of age. A high amount of program viewing was associated with an increased risk of psychosocial problems, while the use of electronic games seemed less problematic. Program viewing at five years of age had an association with all of the FTF subscales (OR=1.64-1.98, p<0.05) and with SDQ hyperactivity (OR=2.43, p<0.01) and conduct problems (OR=1.48, p=0.04). In the fully-adjusted model, an increased risk appeared for attention and concentration difficulties (OR=1.91, p=0.01) and hyperactivity and impulsivity (OR=1.67, p=0.03), and with SDQ hyperactivity (OR=2.23, p<0.01). In contrast, the use of electronic games was associated with an increased risk of SDQ hyperactivity

(OR=1.65, p=0.02) and only in the unadjusted model, while with the other subscales no increased risk appeared.

Discussion

The aim of this study was to investigate the frequency of preschooler's e-media usage and the risks of high-dose e-media use on young children's psychosocial well-being. The results of our study show that 95% of preschoolers exceed the daily electronic media use recommendation of one hour, which is set by health professionals and pediatricians. Based on our results, increased screen time at five years of age was associated with a risk of multiple psychosocial symptoms, while increased levels of e-media use at 18 months had only few longitudinal associations for psychosocial symptoms at five years of age. Furthermore, high-dose use of electronic games at the age of five years seemed to be associated with fewer risks of psychosocial well-being than program viewing.

Based on the results of this study, preschoolers' average daily screen time is 114 minutes at five years of age. This number is almost two times higher than the recommended daily maximum amount of e-media, which is 60 minutes (5,13). Previous studies on preschoolers' e-media use conducted in Finland have reported similar results, as the total daily screen time was 111 minutes in 2017 (14), while in Belgium it was 81 minutes (29) in 2018. Among American children, the total screen time in 2017 in this age group was somewhat higher: 159 minutes (2). It has been suggested that the products and usage culture of electronic media develops very rapidly in United States (2,30), whereas access to products might occur at a slower pace in other countries. This might explain why the frequency of usage among young children in the US is higher than in Europe.

We discovered that high screen use at 5 years of age was associated with a risk of multiple psychosocial problems. More precisely, elevated levels of total screen time were associated with attention and concentration difficulties, hyperactivity and impulsivity, emotional internalizing and externalizing symptoms, and conduct problems. Similar results have been recently reported on emotional symptoms (19,23,31), conduct problems, and hyperactivity (31). Regarding hyperactivity, previous studies suggest that screen time may hinder the availability for activities that are considered to enhance cognitive capacities and stimulate longer attention span (32). Moreover, the harmful effect of television viewing might function by displacing developmentally important learning opportunities with an attention-capturing stimulus with a lack of developmental value (9,33). Previous studies have also reported associations between increased total screen time and peer problems (31). We did not find such associations at five years. This difference might be explained by the age of the participants: In the study of Wu et al. (2017) the mean age of the participants was 4.37, whereas in our study it was 5.68. In line with this, our findings show that screen time at an earlier age, i.e., at 18 months, was associated with peer problems later on. It seems that a high amount of screen use at a younger age is a risk factor for peer problems. However, unlike some other studies (8,19,23) we did not find high-dose use of electronic devices at 18 months of age to be associated with other problems in psychosocial well-being later on. It is possible that parents regulate younger children's e-media usage habits, while later on, other factors may have a more important role in the amount of usage. These are for example certain inherited personality traits of a child, such as persistence and introversion (34), or their participation in daycare.

Our results show that an increased amount of program viewing at 5 years of age is associated with a risk of several psychosocial problems, while electronic game use had fewer associations, which is also consistent with recent previous studies (6,19,23). Electronic game-playing was only associated with SDQ hyperactivity, whereas no risks were found regarding other psychosocial symptoms. Previous studies have yielded an association between electronic game-playing and emotional symptoms. However, the direction of the association is contradictory: Increased e-game use has been associated with emotional problems (23), but also with better socio-emotional skills (6). The few associations between socioemotional health and game-playing might be explained by the social nature of game-playing: Children often participate in the use of e-games with siblings and other family members, for example, and develop their social and emotional skills in these social interactions (6). All in all, the amount of daily e-game usage in our study and all of these other studies was much lower compared to program viewing, which might explain why e-games are not associated with psychosocial problems to any larger extent at this age.

As our results point out, increased screen time has multiple risks for children's psychosocial well-being. These risk factors might accumulate in the long-term, and cause problems in children's socio-emotional development later on. Health professionals and pediatricians play an important role as communicators of the current research results on the safe usage of e-media for families. Parents' knowledge might further help them to set safe boundaries for young children's e-media use and protect children's psychosocial health from associated risk factors (35).

One possible mechanism accounting for the result might be that the time children spend on e-media reduces the time spend on constructive activities, such as interactions with family members, reading and playing (1,4,7). At an early age, children's socio-emotional development occurs in a dynamic interplay between social learning and environmental factors. Furthermore, if the surrounding environment does not offer enough means for a child's healthy development, it might affect a children's psychosocial well-being (36). Genetic dispositions also play a role in modifying individual risks. However, the direction of the effect of e-media use is unclear, as some parents might use e-media devices as a tool to calm their children down, especially when the child has socio-emotional difficulties (15). It is possible, that there is a bidirectional link between the two factors.

One strength of our study is its longitudinal study setting and its repeated measurement of e-media exposure. Moreover, patterns of children's electronic media usage are rapidly changing, and our study offers results on the associations between young children's e-media use and their psychosocial well-being based on recent data. In addition, the sample is based on a representative birth cohort recruited during pregnancy.

A limitation of our study is that those with lower education seem to be underrepresented in the sample, which is common according to studies on drop-out rates in longitudinal studies on mental health (37). Moreover, single mothers are underrepresented in the sample. Another limitation is that psychosocial symptoms at 18 months of age were not assessed. The measurement of e-media use was based on parental questionnaires and not logs or objective or observational measures. Therefore, the reported amounts of e-media use are prone to recall bias or social-desirability bias (over-reporting or

underreporting the actual usage). If this bias is randomly distributed among the children, it does not affect the findings. However, if it is related to exposure or outcome, it might have some effect on the findings. Thus, in future studies, parent reports of children's e-media use need to be validated with objective measures. However, of note is that in a previous study (14) conducted in Finland among a comparable age-group and using parental logs on child's e-media use, the reported daily total e-media exposure was 111 minutes, while in our study the respective figure was 114 minutes. This suggests that the reported exposures in our study could be relatively reliable. In the future, more research is needed on the family conditions of high-dose e-media users.

Conclusion

This study reported the risks associated with high-dose use of electronic media devices by young children. Our results show that 5-year-old children spend considerably more time on e-media than is recommended by professionals. Our results further indicate that high levels of e-media use, especially program viewing, is associated with problems with psychosocial outcomes, while use of e-games was only associated with hyperactivity in the crude models. Children's social-emotional development is influenced by environmental factors, including electronic media habits. Although children's electronic media use patterns might not seem problematic when considering use on a daily level, they do have risks in the long term. Thus, health professionals play a key role in providing information for parents on screen media parenting, i.e., the safe use of e-media devices among young children in order to protect their healthy development.

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Contributorship statement

EJP and OSH designed the study. JN, OK, and EJP were primarily responsible for data analysis and writing of the article. RV and OSH contributed critically to the writing of the article.

Competing interests

The authors declare no competing interests.

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Data sharing statement

Data is not publicly available due to legal restrictions and confidential nature of the data. Data is available upon request. Requests may be sent to The Finnish Institute for Health and Welfare, who is the controller of the data. For more information about data access, please see https://thl.fi/en/web/thlfi-en/statistics/information-for-researchers.

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Table 1. Descriptive statistics of sociodemographic factors and measures of screen time (N=699).

	% (N)
Sociodemographic factors	
Child's gender	
Girls	47.6 (333)

Boys	52.4 (366)
Child's age, years; mean (SD)	5.68 (0.54)
Maternal education	
University-level degree	63.4 (409)
Less than university-level degree	36.6 (236)
Number of siblings	
0	51.0 (327)
1	32.2 (207)
2	12.9 (83)
3	2.5 (16)
4 or more	1.2 (8)
Full-time daycare	
No	32.3 (214)
Yes	67.7 (448)
Screen time	
Total screen time at 18 months, min; mean (SD), range	32.4 (31.0), 252.9
Over 60 minutes, %	22.7 (136)
Over 120 minutes, %	2.8 (17)
Program viewing at 5 years, min; mean (SD), range	80.4 (36.3), 225.0
Over 60 minutes, %	66.8 (442)
Over 120 minutes, %	16.9 (112)
Electronic game-playing at 5 years, min; mean (SD), range	33.4 (25.9), 182.1
Over 60 minutes, %	10.6 (69)
Over 120 minutes, %	2.3 (15)
Total screen time at 5 years, min; mean (SD), range	114.1 (50.6), 321.4
Over 60 minutes, %	94.6 (615)
Over 120 minutes, %	40.2 (261)
Over 180 minutes, %	11.5 (75)

Table 2. Outcome variables.

Outcome variable	Mean (SD)	Range
FTF		
Attention and concentration difficulties	3.75 (3.41)	18.00
Hyperactivity and impulsivity	3.98 (3.63)	18.00
Emotional/internalizing symptoms	1.52 (1.79)	15.00
Emotional/externalizing symptoms	2.83 (3.25)	21.00
SDQ		
Hyperactivity	3.04 (2.34)	10.00
Emotional problems	1.38 (1.48)	9.00
Conduct problems	1.97 (1.59)	9.00
Peer problems	1.69 (1.38)	9.00

Table 3. Associations between electronic media use at 18 months and 5 years of age with psychosocial well-being at age 5 years.

Screen time: 18 months of age	***Crude***			***Adjusted 1*** [a]			***Adjusted 2*** [b]		
FTF	***OR***	***95% CI***	***p***	***OR***	***95% CI***	***p***	***OR***	***95% CI***	***p***
Attention and concentration difficulties	1.46	0.96-2.22	0.07	1.50	0.97-2.31	0.07	1.41	0.89-2.22	0.14
Hyperactivity and impulsivity	1.16	0.76-1.77	0.50	1.16	0.75-1.81	0.50	1.14	0.72-1.80	0.59
Emotional/internalizing symptoms	1.19	0.76-1.88	0.45	1.15	0.72-1.85	0.55	1.13	0.69-1.86	0.62
Emotional/externalizing symptoms	1.03	0.66-1.60	0.91	1.04	0.65-1.65	0.88	1.06	0.65-1.72	0.82
SDQ									
Hyperactivity	1.49	0.98-2.26	0.06	1.37	0.89-2.12	0.15	1.37	0.87-2.18	0.18
Emotional problems	1.36	0.86-2.17	0.19	1.38	0.85-2.23	0.19	1.47	0.88-2.45	0.14
Conduct problems	1.24	0.84-1.84	0.28	1.26	0.84-1.90	0.27	1.23	0.80-1.90	0.35
Peer problems	**1.59**	**1.04-2.41**	**0.03**	**1.64**	**1.06-2.52**	**0.03**	1.56	0.98-2.46	0.06
Total screen time: 5 years of age									
FTF	***OR***	***95% CI***	***p***	***OR***	***95% CI***	***p***	***OR***	***95% CI***	***p***
Attention and concentration difficulties	**1.88**	**1.27-2.80**	**<0.01**	1.45	0.92-2.28	0.11	1.57	0.97-2.53	0.07
Hyperactivity and impulsivity	**1.57**	**1.06-2.33**	**0.03**	1.33	0.85-2.12	0.22	1.31	0.81-2.13	0.28
Emotional/internalizing symptoms	**1.75**	**1.15-2.65**	**0.01**	**1.84**	**1.14-2.97**	**0.01**	**2.01**	**1.21-3.34**	**0.01**
Emotional/externalizing symptoms	**1.69**	**1.12-2.55**	**0.01**	1.39	0.87-2.23	0.17	1.54	0.94-2.52	0.09
SDQ									
Hyperactivity	**2.18**	**1.49-3.20**	**<0.01**	**1.60**	**1.02-2.49**	**0.04**	1.55	0.97-2.48	0.07
Emotional problems	0.99	0.62-1.56	0.95	0.98	0.58-1.66	0.94	0.90	0.49-1.61	0.70
Conduct problems	**1.53**	**1.05-2.21**	**0.03**	1.24	0.81-1.91	0.32	1.06	0.67-1.67	0.80
Peer problems	1.06	0.71-1.60	0.77	0.90	0.56-1.45	0.67	0.85	0.51-1.42	0.53

[a] Adjusted for age, gender, maternal education. Total screen time at 5 years of age: Also adjusted for screen time at 18 months of age.

[b] Adjusted for age, gender, maternal education, number of siblings, and daycare participation. Total screen time at 5 years of age: Also adjusted for screen time at 18 months of age.

Table 4. Associations between program viewing and use of electronic games at 5 years of age with psychosocial well-being.

Program viewing: 5 years of age	***Crude***			***Adjusted 1*** [a]			***Adjusted 2*** [b]		
FTF	***OR***	***95% CI***	***p***	***OR***	***95% CI***	***p***	***OR***	***95% CI***	***p***
Attention and concentration difficulties	**1.98**	**1.34-2.93**	**<0.01**	**1.71**	**1.10-2.69**	**0.02**	**1.91**	**1.19-3.08**	**0.01**
Hyperactivity and impulsivity	**1.64**	**1.11-2.42**	**0.01**	**1.68**	**1.07-2.63**	**0.02**	**1.67**	**1.04-2.69**	**0.03**
Emotional/internalizing symptoms	**1.68**	**1.11-2.54**	**0.01**	1.59	0.99-2.55	0.06	**1.71**	**1.03-2.84**	**0.04**
Emotional/externalizing symptoms	**1.69**	**1.12-2.55**	**0.01**	1.14	0.71-1.84	0.59	1.19	0.72-1.96	0.50
SDQ									
Hyperactivity	**2.43**	**1.66-3.56**	**<0.01**	**2.29**	**1.47-3.55**	**<0.01**	**2.23**	**1.40-3.54**	**<0.01**
Emotional problems	0.99	0.63-1.56	0.97	0.94	0.56-1.57	0.80	0.86	0.48-1.53	0.60
Conduct problems	**1.49**	**1.03-2.15**	**0.04**	1.31	0.85-2.00	0.22	1.16	0.74-1.82	0.51
Peer problems	1.04	0.69-1.56	0.86	0.93	0.58-1.50	0.77	0.87	0.52-1.44	0.58
Use of electronic games: 5 years of age									
FTF	***OR***	***95% CI***	***p***	***OR***	***95% CI***	***p***	***OR***	***95% CI***	***p***
Attention and concentration difficulties	0.95	0.60-1.51	0.82	0.69	0.41-1.16	0.16	0.67	0.38-1.17	0.16
Hyperactivity and impulsivity	1.20	0.77-1.87	0.42	0.89	0.54-1.48	0.66	0.82	0.48-1.42	0.48
Emotional/internalizing symptoms	1.22	0.76-1.96	0.40	1.27	0.75-2.16	0.38	1.36	0.78-2.40	0.28
Emotional/externalizing symptoms	1.37	0.86-2.16	0.19	1.23	0.74-2.05	0.42	1.42	0.83-2.42	0.20
SDQ									
Hyperactivity	**1.65**	**1.08-2.51**	**0.02**	1.06	0.65-1.72	0.81	0.98	0.58-1.66	0.95
Emotional problems	0.95	0.58-1.58	0.85	1.10	0.63-1.92	0.75	1.04	0.55-1.97	0.90
Conduct problems	1.04	0.69-1.57	0.85	0.88	0.55-1.40	0.58	0.75	0.50-1.25	0.27
Peer problems	1.10	0.71-1.70	0.69	0.87	0.52-1.46	0.60	0.83	0.48-1.44	0.51

[a] Adjusted for age, gender, maternal education, screen time at 18 months of age.

[b] Adjusted for age, gender, maternal education, siblings, and daycare participation, screen time at 18 months of age.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Abstract page
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	1-2
Objectives	3	State specific objectives, including any prespecified hypotheses	2
Methods			
Study design	4	Present key elements of study design early in the paper	2-3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	2-3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	3
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	3-4
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	3-4
Bias	9	Describe any efforts to address potential sources of bias	8
Study size	10	Explain how the study size was arrived at	3
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	3-4
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	4-5
		(*b*) Describe any methods used to examine subgroups and interactions	-
		(*c*) Explain how missing data were addressed	3
		(*d*) If applicable, explain how loss to follow-up was addressed	
		(*e*) Describe any sensitivity analyses	-

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	3-4
		(b) Give reasons for non-participation at each stage	3-4
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	4-5
		(b) Indicate number of participants with missing data for each variable of interest	4
		(c) Summarise follow-up time (eg, average and total amount)	4-5
Outcome data	15*	Report numbers of outcome events or summary measures over time	Table 2
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Tables 3 and 4
		(*b*) Report category boundaries when continuous variables were categorized	3-4
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	6
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8
Generalisability	21	Discuss the generalisability (external validity) of the study results	8
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	9

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.