

# BMJ Open 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 electronic media (e-media) usage by preschool children and the risks of high-dose e-media use on young children's psychosocial well-being.

**Design** Longitudinal associations between e-media use at 18 months and psychosocial symptoms at 5 years of age were studied, as well as cross-sectional associations between e-media use and psychosocial symptoms at 5 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 determined at the age of 5 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 preschool children exceeded the daily recommended use of e-media set by health professionals. Our results indicate that increased screen time at 5 years of age is associated with a risk of multiple psychosocial symptoms (OR 1.53–2.18, 95% CI 1.05 to 3.34, p<0.05), while increased levels of e-media use at 18 months was only associated with FTF peer problems (OR 1.59, 95% CI 1.04 to 2.41, p=0.03). Moreover, high-dose use of electronic games at the age of 5 years seems to be associated with fewer risks for psychosocial well-being than programme viewing, as it was only associated with SDQ hyperactivity (OR 1.65, 95% CI 1.08 to 2.51, 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 paediatricians have an important role as communicators of the current research results on the safe usage time of e-media for families, and enhancing parents' skills as regulators of children's safe e-media use. More research is needed on the family conditions of high-dose e-media users.

## 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

## Strengths and limitations of this study

- A major strength of our study is the longitudinal study setting and repeated measurement of e-media exposure.
- Patterns of children's e-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.
- Moreover, the sample is based on a representative birth cohort recruited during pregnancy.
- A limitation of our study is the measurement of e-media use, which was based on parental questionnaires and not logs.
- Single mothers as well as those with lower education seem to be under-represented in the sample.

behaviour.<sup>1</sup> Traditional e-media is often used: nearly half of preschool-age children watch TV,<sup>2</sup> use a laptop or desktop computer and play video consoles daily.<sup>3</sup> 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.<sup>2</sup> 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.<sup>3</sup>

Electronic media use (ie, total screen time) comprises programme viewing (ie, watching of programmes from TV, DVDs, mobile devices), as well as use of social media, internet and electronic games. While the negative forms of e-media use (eg, playing electronic games alone) are often emphasised, healthier forms also exist. A reasonable amount of educational e-media material (eg, serious games) might have beneficial effects on young children's psychosocial well-being and development.<sup>4</sup> Moreover, e-media use involving social interactions, such as use with caregivers, might have fewer risks than

e-media use alone, as parents can help children to understand what they are seeing.<sup>5</sup> Use of electronic games with siblings and peers seems also to be less risky.<sup>6</sup>

High-dose use of e-media in young children can be a risk factor for the development of the 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.<sup>1 4 7–9</sup> Thus, high-dose use of e-media can also be related to the child's development, such as language development<sup>10</sup> or development of social skills,<sup>11</sup> which are important to children's psychosocial health. High-dose use can also develop into a behavioural addiction. While studied less among children, according to a recent study, internet- or screen-based behavioural 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 the loss of a child's previous hobbies and interests.<sup>12</sup>

The World Health Organisation has published guidelines for the total screen time of children aged 2–4 years. The recommendation is a maximum of 1 hour per day for this age group.<sup>13</sup> However, in previous studies, much higher amounts have been reported. For example, among American children aged 2–4 years the average total screen time per day was 159 min,<sup>2</sup> and among Finnish children aged 3–6 years it was 111 min.<sup>14</sup> 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.<sup>15–18</sup> Thus, the link between e-media use and psychosocial symptoms seems to be bidirectional.

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

As the patterns of children's e-media usage are rapidly changing, 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 high-dose e-media use on the well-being of preschool-age children, few of these studies have analysed the longitudinal associations of early exposure to e-media with children's later psychosocial problems. According to these studies, it seems that high-dose e-media use that starts at

an early age might be detrimental for young children's psychosocial health later on.<sup>8 19 23</sup>

The aim of this research is to assess the amount of e-media usage by preschool children and its associations with their psychosocial well-being. We studied longitudinal associations between e-media use at 18 months and psychosocial symptoms at 5 years of age, as well as cross-sectional associations between e-media use (programme viewing and electronic game-playing) and psychosocial symptoms at 5 years. Psychosocial symptoms—that is, internalising and externalising problems and inattention—were assessed at 5 years of age. We hypothesised that children who use large amounts of e-media at 18 months of age have more psychosocial symptoms at 5 years than those who use less. Moreover, we hypothesised that programme viewing is associated with more problems in psychosocial health, while use of electronic games has fewer 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 by Paavonen *et al.*<sup>24</sup> The recruitment and baseline measurement took place prenatally at 32 weeks and the follow-up measurements were performed at the birth of the child and at 3, 8, 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 centres. Participants were asked to give their written informed consent. Participation in 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. A total of 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 (eg, 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)<sup>25</sup> or the Five-to-Fifteen (FTF)<sup>26</sup> questionnaire at the children's age of 5 years. Questions regarding the child were asked of both parents at 5 years; 73.4% of the answers were completed by the mother alone, 1.0% by the father alone and 25.5% by both parents. 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 the children's psychosocial symptoms. Information concerning maternal sociodemographic factors such as education and number of previous children were asked prenatally and were available for 641 children.

## Measures

### Screen time

Parents reported the time a child spent engaged in e-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 programmes (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 were collected.<sup>2</sup>

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

### Outcomes at 5 years of age

Children's psychosocial symptoms were asked at the age of 5 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—that is, emotional and behavioural problems and inattention—were included.

The FTF questionnaire has been tested for its validity and reliability for the identification of internalising and externalising symptoms in children aged 5–15 years.<sup>26 27</sup> The items are categorised into eight different domains and 22 subdomains, of which we used the following four subdomains: attention and concentration difficulties,

hyperactivity and impulsivity, emotional internalising problems and emotional externalising problems.<sup>28</sup>

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,<sup>25</sup> and is widely used for research purposes.<sup>19 23</sup> 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 raised levels of psychosocial symptoms. The cut-off points for the FTF scales sum scores were: attention and concentration problems  $\geq 6$  (26%, n=172), hyperactivity and impulsivity  $\geq 6$  (27.9%, n=185), emotional internalising problems  $\geq 2$  (22.3%, n=152) and emotional externalising problems  $\geq 4$  (22.9%, n=152). Accordingly, the cut-off points for the SDQ scale sum scores were: inattention-hyperactivity  $\geq 5$  (25.7%, n=171), emotional problems  $\geq 2$  (18.6%, n=124), conduct problems  $\geq 3$  (32.8%, n=218) and peer problems  $\geq 3$  (25.1%, n=167).

### Covariates

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

### Statistical analyses

Data were analysed using IBM SPSS Statistics Version 25. Frequencies of categorical/dichotomous variables as well as means and SD of the continuous study variables were calculated first (see tables 1 and 2). Logistic regression analyses were then conducted to calculate ORs and their 95% CIs for the associations between e-media use and outcomes. Longitudinal associations between e-media use at 18 months and FTF and SDQ scales at 5 years were first analysed (upper part of table 3). Cross-sectional associations between e-media use and each of the subscales of FTF and SDQ at 5 years were then analysed (Table 4 and lower part of table 3). 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 5 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 shown in table 1. The mean (SD) age of the children in the sample was 5.7 (0.5) years. The sample consisted of 333 girls (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.

**Table 1** Descriptive statistics of sociodemographic factors and measures of screen time (n=699)

	% (N)
<b>Sociodemographic factors</b>	
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	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 (max-min)	
>60 min, %	22.7 (136)
>120 min, %	2.8 (17)
Programme viewing at 5 years (min), mean (SD), range (max-min)	
>60 min, %	66.8 (442)
>120 min, %	16.9 (112)
Electronic game-playing at 5 years (min), mean (SD), range (max-min)	
>60 min, %	10.6 (69)
>120 min, %	2.3 (15)
Total screen time at 5 years (min), mean (SD), range (max-min)	
>60 min, %	94.6 (615)
>120 min, %	40.2 (261)
>180 min, %	11.5 (75)

On average, at 18 months of age, children spent a mean (SD) of 32.4 (31.0) min/day with e-media devices. At 5 years the mean (SD) time spent with e-media devices was 114.1 (50.6) min/day (range 321). Programme viewing (mean (SD) 80.4 (36.3) min/day) was more popular than the use of electronic games (mean (SD) 33.4 (25.9) min/day).

At 18 months, 22.7% of the children spent >60 min consuming screen media each day, while at 5 years of age the percentage was 94.6%. Moreover, 66.8% of the children viewed programmes for >60 min/day, whereas

**Table 2** Outcome variables

Outcome variable	Mean (SD)	Range (max-min)
<b>FTF</b>		
Attention and concentration difficulties	3.75 (3.41)	18.00
Hyperactivity and impulsivity	3.98 (3.63)	18.00
Emotional/internalising symptoms	1.52 (1.79)	15.00
Emotional/externalising symptoms	2.83 (3.25)	21.00
<b>SDQ</b>		
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

FTF, Five-to-Fifteen Questionnaire; SDQ, Strengths and Difficulties Questionnaire.

10.6% of the children spent >60 min/day using electronic games.

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

Table 3 shows the ORs for the associations between e-media use at 18 months and 5 years of age on each of the subscales of FTF and SDQ. Based on the results, e-media use at 18 months had less of a negative effect than at 5 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 adjusting for children's age, gender and parents' socioeconomic status (OR 1.64, p=0.03). There was no increased risk of psychosocial problems with other subscales of FTF and SDQ.

In contrast, increased levels of total screen time at 5 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), internalising symptoms (OR 1.75, p=0.01) and externalising 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 significant associations other than the increased risk of FTF internalising symptoms (OR 2.01, p=0.01).

Table 4 shows the ORs for the associations between programme viewing and the use of electronic games on each of the subscales of FTF and SDQ among children at 5 years of age. A high amount of programme viewing was associated with an increased risk of psychosocial problems, while the use of electronic games seemed less problematic. Programme viewing at 5 years of age had an association with all of the FTF subscales (OR 1.64–1.98,

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

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

Bold indicates statistical significance at  $p < 0.05$ .

\*Adjusted for age, gender, maternal education. Total screen time at 5 years of age; also adjusted for screen time at 18 months of age.

†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.

FTF, Five-to-Fifteen Questionnaire; SDQ, Strengths and Difficulties Questionnaire.

$p < 0.05$ ) and with SDQ hyperactivity (OR 2.43,  $p < 0.01$ ) and conduct problems (OR 1.49,  $p = 0.04$ ). In the fully-adjusted model, an increased risk appeared for attention and concentration difficulties (OR 1.91,  $p = 0.01$ ), hyperactivity and impulsivity (OR 1.67,  $p = 0.03$ ), and emotional/internalizing symptoms (OR 1.71,  $p = 0.04$ ) as well as 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,  $p = 0.02$ ) 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 e-media use by preschool children 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 preschool

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

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

Bold indicates statistical significance at  $p < 0.05$ .

\*Adjusted for age, gender, maternal education, screen time at 18 months of age.

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

FTF, Five-to-Fifteen Questionnaire; SDQ, Strengths and Difficulties Questionnaire.

aged children exceed the recommended daily e-media use of 1 hour, which is set by health professionals and paediatricians. Based on our results, increased screen time at 5 years of age was associated with a risk of multiple psychosocial symptoms, while increased levels of e-media use at 18

months had only a few longitudinal associations for psychosocial symptoms at 5 years of age. Furthermore, high-dose use of electronic games at the age of 5 years seemed to be associated with fewer risks of psychosocial well-being than programme viewing.

Based on the results of this study, the average daily screen time of preschool children is 114min at 5years of age. This number is almost two times higher than the recommended daily maximum amount of e-media, which is 60min.<sup>5 13</sup> Previous studies on preschool children's e-media use conducted in Finland have reported similar results with a total daily screen time of 111min in 2017,<sup>14</sup> while in Belgium it was 81min in 2018.<sup>29</sup> In American children, the total screen time in 2017 in this age group was somewhat higher at 159min.<sup>2</sup> It has been suggested that the products and usage culture of e-media develop very rapidly in USA,<sup>2 30</sup> 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 USA is higher than in Europe.

We found that high levels of screen use at 5 years of age was associated with a risk of multiple psychosocial problems. More precisely, high levels of total screen time were associated with attention and concentration difficulties, hyperactivity and impulsivity, emotional internalising and externalising symptoms, and conduct problems. Similar results have recently been reported for emotional symptoms,<sup>19 20 23</sup> conduct problems and hyperactivity.<sup>20</sup> 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.<sup>31</sup> 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.<sup>9 32</sup> Previous studies have also reported associations between increased total screen time and peer problems.<sup>20</sup> We did not find such associations at 5years. This difference might be explained by the age of the participants. In the 2017 study by Wu *et al.* the mean age of the participants was 4.4 years compared with 5.7 years in our study. In line with this, our findings show that screen time at an earlier age (ie, 18 months) was associated with peer problems later on. It seems that a high level of screen use at a younger age is a risk factor for peer problems. However, unlike some other studies,<sup>8 19 23</sup> we did not find a high usage level 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 including, for example, certain inherited personality traits of a child such as persistence and introversion,<sup>33</sup> or their participation in daycare.

Our results show that an increased amount of programme 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.<sup>6 19 23</sup> Electronic game-playing was only associated with SDQ hyperactivity, whereas no risks were found regarding other psychosocial symptoms. Previous studies have reported an association between electronic game-playing and emotional symptoms. However, the direction of the association is contradictory. Increased electronic game-playing has been associated with emotional problems,<sup>33</sup> but also with better socio-emotional skills.<sup>6</sup> The few associations

between socio-emotional health and game-playing might be explained by the social nature of game-playing. Children often participate in electronic game-playing with siblings and other family members, for example, and develop their social and emotional skills in these social interactions.<sup>6</sup> All in all, the amount of daily electronic game usage in our study and in all the other studies was much lower compared with programme viewing, which might explain why electronic 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 paediatricians have 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.<sup>34</sup>

One possible mechanism accounting for the result might be that the time children spend on e-media reduces the time spent on constructive activities such as interactions with family members, reading and playing.<sup>14 7</sup> 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 their psychosocial well-being.<sup>35</sup> 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.<sup>15</sup> 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 e-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 under-represented in the sample, which is common according to studies on drop-out rates in longitudinal studies on mental health.<sup>36</sup> Single mothers are also under-represented 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 under-reporting 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, parental reports of children's e-media use need to be

validated with objective measures. However, it is noteworthy that, in a previous study<sup>14</sup> conducted in Finland among a comparable age group and using parental logs on children's e-media usage, the reported daily total e-media exposure was 111 min, while in our study the figure was 114 min. This suggests that the reported exposures in our study are 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 levels of use of e-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 programme viewing, is associated with problems with psychosocial outcomes, while use of electronic games was only associated with hyperactivity in the crude models. Children's social-emotional development is influenced by environmental factors, including e-media habits. Although children's e-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 the safe use of e-media devices in young children in order to protect their healthy development.

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