

Screen time and early children's emotional, behavioural and social development: Findings from the Growing Up in Scotland (GUS) cohort study

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Abstract

Background

There has been limited evidence supporting the association between the quantity of screen time and children's early development. This study aims to examine how the length of screen time, especially with television, was associated with childhood development by analysing the Growing Up in Scotland (GUS) study.

Methods

We cross-sectionally analysed the GUS birth cohort data of children aged 4 and 6. The Strength and Difficulties Questionnaire (SDQ) score was used to assess the children development. Multivariate binary logistic models were used to evaluate the association between screen time and each SDQ score at ages 4 and 6 and examine the longitudinal impacts of screen time at age 4.

Results

The longitudinal analysis showed that 16.50 hours or more per week at age 4 was significantly associated with hyperactivity/inattention (Odds ratio (OR): 1.39, 95% CI: 1.05–1.84) and conduct problems (OR: 1.45, 95% CI: 1.11–1.89) at age 6. A high level of screen time was associated with increased risks of hyperactivity/inattention problems at age 4 (OR: 1.26, 95% CI: 1.02–1.56) and age 6 (OR: 1.43, 95% CI: 1.10–1.86). Furthermore, the high level of screen time was associated with conduct problems at age 4 (OR: 1.41, 95% CI: 1.09–1.82) and age 6 (OR: 1.35, 95% CI: 1.02–1.79).

Conclusions

High TV screen time in early childhood was significantly associated with a high risk of behavioural problems. However, we did not analyse the contents of the screen. Further research is needed to incorporate more potential confounders.

Introduction

Screens have become pivotal in our daily lives. Screens encompass a wide range of digital devices such as TV, mobile phones, digital video disc (DVD), handheld game devices, tablet PC, and children's learning devices [1]. As the amount of time spent using digital devices is increasing, screen time in children has become a great concern. Some studies showed that screen-based sedentary behaviours were associated with overweight, increased BMI, decreased academic attainment and self-esteem, along with lower prosocial behaviours [2–6]. These concerns grow for young children's development as their brains are more sensitive or vulnerable to specific exposure or stimulation [7, 8]. Their screen time is likely to exceed what is recommended since those children, typically preschoolers, are prone to rely on their parents' choices, unlike older children who tend to express their preferences and decide proactively about their viewing [9–12].

Several screen time guidelines are available regarding screen time in this age group. The World Health Organisation and the American Academy of Paediatrics (AAP) recommend that children under 18 months avoid viewing screen media, and those between 18 and 24 months should be limited to watching educational media content. For those aged 2 to 5 years, screen time should be less than an hour per weekday and 3 hours on weekend days [11, 13]. Similarly, the Canadian Paediatric Society (CPS) recommends no screen time for children younger than 2 years and less than one hour per day for those aged 2 to 5 years [12]. To reduce sedentary behaviour related risks, screen time should be a part of parenting that teaches self-regulation [12]. In the United Kingdom (UK), guidelines by the Royal College of Paediatrics and Child Health (RCPCH) recommend that families should negotiate media plans with their children depending on their needs rather than suggesting a cut-off for screen time [10].

However, not all evidence supported negative associations between higher screen time and children's development [14–18]. As many researchers noted, external factors such as family interaction, socioeconomic status and relevant policies such as a

program rating system could confound the association between screen time and children's developmental outcomes [16, 19–22]. Given that most of the studies on this topic have been conducted in North America [16], it is critical to examine associations between screen time and children's development in the Scottish context considering different cultural or political circumstances in governmental support for parenting. Therefore, this current study analysed data from the Growing Up in Scotland (GUS) study, a prospective cohort study that tracked national cohorts of children and their families since 2005 [23].

This study aimed to investigate the association between screen time and children's emotional, behavioural, and social development. Firstly, we assessed associations between concurrent screen time and the three developmental domains of children at ages 4 and 6. We also examined whether screen time predicts greater developmental problems at age 6 from previous developmental outcomes at age 4.

Methods

Growing Up in Scotland study: participants and design

The Growing Up in Scotland (GUS) study includes children from two birth cohorts born in 2004/2005 (BC1) and 2010/2011 (BC2) and one child cohort born in 2002/2003 (CC), and their families who were randomly recruited from local authority regions in Scotland. Only one child per household was enrolled in the study. During the whole study process, any participant has a right to decline their participation at any time. Data collection was based on a face-to-face interview using laptop computers with the main caretaker (typically mothers) in a household [24]. The study was reviewed by Scotland 'A' MREC committee (application reference: 04/M RE 1 0/59). While CC and BC2 were collected three to four times before reaching age 6, BC1 data were collected annually from age 2 to age 6 and every 2 years until age 14. Each collected data forms a 'sweep' consisting of a broad range of data - around 1000 to 3000 variables - from children and their caretakers. This study used sweeps 4 and 6 of BC1, where the data were collected from ages 4 and 6 years, by which time almost all children would have commenced primary school [23].

We examined the main variables of interest through our previous literature review and documents provided by the GUS study. Subsequently, the most pertinent variables were compared with the GUS data dictionary and selected for the predetermined research questions (Table S1).

Screen time

We defined screen time as the amount of TV viewing time. We did not include other devices because TV was commonly available across sweeps. Screen time was measured by the length of time spent watching TV on weekdays and weekends. For age 4, average TV viewing time on a weekday and weekend, including Saturday and Sunday, was examined, whereas TV viewing time on a typical Saturday was asked for age 6. Accordingly, we calculated differently for weekly TV viewing time per sweep (Table S2). After calculating weekly screen time, we recoded it into quintiles to deal with a skewed screen time distribution and mitigate the impact of outliers.

Children's development

We used the Goodman's Strengths and Difficulties Questionnaire (SDQ) to assess children's emotional, social and behavioural characteristics [25]. The SDQ questionnaire is a validated tool with a 25-item measurement composed of five scales: conduct problems (five items), hyperactivity/inattention (five items), emotional symptoms (five items), peer problems (five items) and prosocial behaviour (five items) (Table S3). Items were rated on a 3-point Likert scale: not true (0), somewhat true (1), certainly true (2). Each scale score was obtained by adding the scores for the five items. Thus, the range of the score is from zero to 10. Except for the prosocial scale, the higher score, the greater evidence of difficulties. As the prosocial scale asks about possible social behaviour, a high score means a lack of difficulties, opposite to other scores [25]. All, except the prosocial scale, are used to generate the total difficulties score ranging from zero to 40, indicating "normal", "borderline abnormal", and "abnormal" by cut-offs (Table S4). The prosocial scale was recorded in the reverse direction to align with other scales, where each child's prosocial score was subtracted from 10, the maximum score. By doing this, a higher score means higher difficulties (≥ 5 for the *reversed* prosocial behaviour score) without changing the potential range of scores (0–10).

Family covariates

Household information included a child's gender, main caretaker ethnicity, presence of other children in a family, and family type (lone/couple). We used the Scottish Index of Multiple Deprivation 2006/09 (SIMD) as a socioeconomic status indicator. This index provides "a relative measure of deprivation across small areas in Scotland" [26]. SIMD is described with the 'Data zone' domain, ranked from the most deprived zone to the least deprived zone based on the overall SIMD. The data zones were categorised into quintiles (Q1, least deprived – 5, most deprived), and these are available in the GUS data. Other recoded variables are described in Table S1.

Data analysis

The analysis began with a descriptive summary of the main variables, including sociodemographic data, frequencies and numbers for the categorical variable. For categorical variables, information was treated as missing data when the respondent refused to respond or responded as 'do not know'; when the item was not applicable to the question or when the schedule or postcode of respondents was not applicable. Missing data were excluded before entering the analysis.

The distribution of the SDQ scale scores was strongly skewed over the sample. For fitting our logistic regression models, the scale scores were dichotomised into "low difficulties" and "high difficulties (borderline abnormal or abnormal)". The abnormal/borderline abnormal score was ≥ 14 for *Total difficulties*, ≥ 4 for *Emotional problems*, ≥ 3 for *Conduct Problems*, ≥ 6 for *Hyperactivity/Inattention problems*, ≥ 3 for *Peer Problems* [25].

To quantify the strength of associations between variables, we used Spearman's rank correlation as a non-parametric method [27]. Herein, examined associations at both ages were as follows: 1) Screen time and SDQ scale score; 2) Screen time and Covariates; 3) SDQ scale score and Covariates.

We applied unadjusted binary logistic regression models to understand crude associations between binary SDQ 'difficulties' classifications and screen time. Quintiles of screen time at each age were entered in the model of binary SDQ difficulties, ignoring all covariates (Table S5). Subsequently, we employed multivariate binary logistic regression models where other exposure variables were included to adjust the association between high SDQ outcomes and quintiles of screen time.

Lastly, we further adjusted the child's SDQ scale score at age 4 in the multivariate binary logistic model to examine whether there were associations between high SDQ scale scores and screen time at age 6. All analyses were undertaken in IBM® SPSS statistics 24.

Results

A total of 3,994 responses at 4 years of age and 3,657 responses at 6 years of age were included in the analysis. For age 4, 51.3% were boys, 76.2% had siblings in a household, and 85.2% lived with one or both parents rather than other caretakers, and for age 6, 51.1% were boys, 82.9% had siblings, and 84.1% lived with parent(s), respectively. Median weekly viewing of TV time was 11 hours (range: 0 to 30 hours) at age 4 and 9 hours (range: 0–25 hours) at age 6, respectively. Table 1 shows the characteristics of sociodemographic data.

Table 1
 Characteristics of GUS study children (or family) at ages 4 and 6 years

Variables	Categories	Age 4 yrs	Age 6 yrs
		N (%)	N (%)
Gender	Male	2,048 (51.3)	1,868 (51.1)
	Female	1,946 (48.7)	1,789 (48.9)
	Total	3,994 (100.0)	3,657 (100.0)
Ethnicity	White	3,875 (97.1)	3,552(97.1)
	Non-white	116 (2.9)	99 (2.7)
	Total	3,991(100.0)	3,651 (100)
Presence of siblings	No	950 (23.8)	625 (17.1)
	Yes	3,044 (76.2)	3,032 (82.9)
	Total	3,994(100.0)	3,657 (100.0)
Family type	Lone	593 (14.8)	581(15.9)
	Couple	3,401(85.2)	3,076(84.1)
	Total	3,994 (100.0)	3,657 (100.0)
SIMD 2006/09	Q1 (least deprived)	873(21.9)	821(22.5)
	Q2	862 (21.6)	837(22.9)
	Q3	833(20.9)	742(20.3)
	Q4	672 (16.8)	643 (17.6)
	Q5 (most deprived)	754 (18.9)	613(16.8)
	Total	3,994 (100.0)	3,656(100.0)
Parents/caregiver's educational attainment	Less than Higher Grade qualification	1,459 (36.6)	1,257 (34.4)
	Higher Grade qualification or vocational or further education qualification	2,526(63.4)	2,393 (65.6)
	Total	3,985 (100.0)	3,650 (100.0)
Employment	Unemployed or Others ¹	1,449 (36.3)	1,186(32.5)
	Full-time paid	825 (20.7)	905 (24.8)
	Part-time paid	1,718 (43.0)	1,563 (42.8)
	Total	3,992 (100.0)	3,654 (100.0)
Screen time*	Hours per day	1.57 (0 to 4.29)	1.29 (0 to 3.57)
	Hours per week	11 (0 to 30)	9 (0 to 25)

*Median (range). SIMD: the Scottish Index of Multiple Deprivation Score

Variables	Categories	Age 4 yrs	Age 6 yrs
	Total	3,931	3,627
*Median (range). SIMD: the Scottish Index of Multiple Deprivation Score			

Table 2 illustrates the correlations between covariates and screen time. Significant negative correlations were reported between screen time and family type (lone parent), main caretaker's educational level (less than higher grade qualification), and main caretaker's employment status (unemployed or others) at both ages. The SIMD quintiles and SDQ subscale scores (using the reverse prosocial score) were positively correlated with higher screen time.

Table 2
Correlations between covariates and screen time (hrs/week) at ages 4 and 6 years
(Spearman's)

Covariates	Age 4 yrs		Age 6 yrs	
	Correlation (r)	P value	Correlation (r)	P value
Gender	-0.027	0.092	-0.014	0.398
Presence of siblings	-0.004	0.805	-0.036	0.031
Family type	-0.058	< 0.001	-0.075	< 0.001
Caretaker's educational level	-0.111	< 0.001	-0.106	< 0.001
Caretaker's employment status	-0.047	0.003	-0.049	0.003
Ethnicity	0.026	0.107	0.038	0.024
SIMD 2006/09	0.133	< 0.001	0.139	< 0.001
SDQ scale scores				
Emotional symptoms	0.047	0.003	0.043	0.010
Conduct problems	0.076	< 0.001	0.092	< 0.001
Hyperactivity/inattention	0.078	< 0.001	0.106	< 0.001
Peer problems	0.058	< 0.001	0.052	0.002
Total difficulties	0.092	< 0.001	0.105	< 0.001
Prosocial behaviour (reverse)	0.040	0.013	0.034	0.043
SIMD: Scottish Index of Multiple Deprivation 2006/09				

The univariate and multivariate binary logistic regression results are presented in Tables 3 and 4. At age 4, the crude results showed significant associations between the highest screen time (≥ 18.50 hrs/week) and high conduct problems, high hyperactivity/inattention, high peer problems, high total difficulties and lower prosocial behaviour at age 4 (Table 3). Similar associations with the highest screen time (≥ 16.50 hrs) and high emotional symptoms, high conduct problems, high hyperactivity/inattention, high peer problems, and high total difficulties were observed at age 6 (Table 4). However, any level of screen time was not strongly associated with high emotional difficulties at age 4 years and low prosocial behaviour at age 6.

Multivariate binary regression models explored associations between binary SDQ score and weekly screen time for quintiles 2 to 5 relative to the 1st Quintile adjusted for child's gender, family type, caretaker's educational level and SIMD 2006/9 (Table 4). At age 4, the same associations between the highest screen time and SDQ categories except high emotional symptoms were observed. For age 6, the highest level of screen time was only associated with high conduct problems, hyperactivity/inattention, and total difficulties.

Table 3

Unadjusted and adjusted binary logistic regression analysis of associations between binary SDQ scores (high vs low) at each age 4 years and Weekly screen time for quintiles (hrs/week)

		Q2 (6.20 to 8hrs)		Q3 (8.10 to 12hrs)		Q4 (12.50 to 18hrs)		Q5 (\geq 18.50hrs)	
Binary SDQ score (high/low)	N	OR (95%CI)	<i>P</i> value	OR (95%CI)	<i>P</i> value	OR (95%CI)	<i>P</i> value	OR (95%CI)	<i>P</i> value
High emotional symptoms									
Unadjusted	3,911	0.611 (0.393, 0.949)	0.028	0.825 (0.562, 1.210)	0.325	0.935 (0.648, 1.351)	0.722	1.141 (0.796, 1.636)	0.474
Adjusted	3,902	0.627 (0.402, 0.979)	0.040	0.799 (0.542, 1.178)	0.257	0.877 (0.604, 1.273)	0.488	0.982 (0.680, 1.420)	0.925
High conduct problems									
Unadjusted	3,910	0.857 (0.683, 1.075)	0.181	1.008 (0.816, 1.245)	0.944	1.133 (0.922, 1.393)	0.236	1.482 (1.205, 1.823)	< 0.001
Adjusted	3,901	0.849 (0.673, 1.070)	0.165	0.966 (0.778, 1.198)	0.750	1.050 (0.850, 1.297)	0.648	1.262 (1.020, 1.562)	0.033
High hyperactivity/ Inattention									
Unadjusted	3,902	0.972 (0.734, 1.289)	0.846	1.272 (0.984, 1.644)	0.066	1.171 (0.905, 1.515)	0.229	1.686 (1.314, 2.164)	< 0.001
Adjusted	3,893	0.956 (0.717, 1.275)	0.760	1.206 (0.929, 1.566)	0.160	1.048 (0.806, 1.364)	0.725	1.409 (1.090, 1.821)	0.009
High peer problems									
Unadjusted	3,904	0.868 (0.645, 1.168)	0.350	0.990 (0.752, 1.303)	0.942	1.132 (0.869, 1.476)	0.358	1.541 (1.190, 1.995)	0.001
Adjusted	3,895	0.883 (0.655, 1.191)	0.415	0.969 (0.734, 1.278)	0.822	1.078 (0.824, 1.409)	0.585	1.363 (1.048, 1.774)	0.021
High total difficulties									
Unadjusted	3,879	0.745 (0.507, 1.094)	0.133	1.042 (0.744, 1.458)	0.812	1.145 (0.826, 1.587)	0.417	2.044 (1.511, 2.764)	< 0.0001
Adjusted	3,870	0.733 (0.495, 1.085)	0.120	0.983 (0.697, 1.386)	0.921	1.007 (0.720, 1.408)	0.967	1.650 (1.207, 2.255)	0.002
Low prosocial behaviour									
Unadjusted	3,906	0.823 (0.577, 1.173)	0.281	1.170 (0.857, 1.598)	0.322	0.935 (0.677, 1.292)	0.684	1.540 (1.141, 2.080)	0.005
Adjusted	3,897	0.787 (0.551, 1.124)	0.188	1.122 (0.820, 1.535)	0.473	0.867 (0.626, 1.202)	0.393	1.451 (1.069, 1.970)	0.017

Model adjustments included child's gender, family type, parent/caregiver's educational level, and SIMD 2006/2009. Reference categories: 'low emotional symptoms', 'low conduct problems', 'low hyperactivity/inattention', 'low peer problems, and 'high prosocial behaviour'

Table 4

Unadjusted and adjusted binary logistic regression analysis of associations between binary SDQ scores (high vs low) at each age 6 years and Weekly screen time for quintiles (hrs/week)

		Q2 (6.50 to 8.50hrs)		Q3 (9 to 11hrs)		Q4 (11.50 to 16hrs)		Q5 (\geq 16.50hrs)	
Binary SDQ score (high/low)	N	OR (95%CI)	<i>P</i> value	OR (95%CI)	<i>P</i> value	OR (95%CI)	<i>P</i> value	OR (95%CI)	<i>P</i> value
High emotional symptoms									
Unadjusted	3,605	0.869 (0.596, 1.267)	0.465	1.033 (0.733, 1.457)	0.852	0.822 (0.575, 1.174)	0.281	1.504 (1.062, 2.131)	0.022
Adjusted	3,597	0.857 (0.586, 1.255)	0.428	1.045 (0.740, 1.478)	0.801	0.768 (0.536, 1.100)	0.150	1.285 (0.901, 1.834)	0.166
High conduct problems									
Unadjusted	3,608	0.964 (0.737, 1.260)	0.788	1.044 (0.812, 1.342)	0.735	1.215 (0.952, 1.551)	0.118	1.695 (1.310, 2.191)	< 0.001
Adjusted	3,600	0.944 (0.717, 1.242)	0.679	1.052 (0.814, 1.359)	0.698	1.120 (0.873, 1.437)	0.374	1.428 (1.095,1.861)	0.008
High hyperactivity/Inattention									
Unadjusted	3,603	0.897 (0.675, 1.194)	0.457	0.902 (0.689, 1.182)	0.455	1.133 (0.875, 1.467)	0.343	1.600 (1.221, 2.096)	0.001
Adjusted	3,595	0.882 (0.659, 1.179)	0.396	0.902 (0.685, 1.187)	0.461	1.050 (0.807, 1.365)	0.719	1.353 (1.024, 1.786)	0.033
High peer problems									
Unadjusted	3,604	1.147 (0.821, 1.602)	0.421	1.030 (0.745, 1.424)	0.857	1.139 (0.831, 1.561)	0.418	1.734 (1.258, 2.391)	0.001
Adjusted	3,596	1.126 (0.800, 1.583)	0.497	1.048 (0.755, 1.456)	0.779	1.028 (0.746, 1.417)	0.866	1.389 (0.998, 1.932)	0.051
High total difficulties									
Unadjusted	3,594	0.875 (0.596, 1.285)	0.496	0.874 (0.608, 1.257)	0.469	1.282 (0.917, 1.793)	0.146	1.955 (1.391, 2.749)	< 0.001
Adjusted	3,586	0.842 (0.566, 1.251)	0.394	0.883 (0.609, 1.281)	0.513	1.129 (0.801, 1.592)	0.488	1.496 (1.051, 2.128)	0.025
Low prosocial behaviour									
Unadjusted	3,606	0.768 (0.486, 1.214)	0.258	0.968 (0.643, 1.458)	0.876	1.007 (0.673, 1.506)	0.973	1.052 (0.678, 1.632)	0.822

Model adjustments included child's gender, family type, parent/caregiver's educational level, and SIMD 2006/2009. Reference categories: 'low emotional symptoms', 'low conduct problems', 'low hyperactivity/inattention', 'low peer problems, and 'high prosocial behaviour'

		Q2 (6.50 to 8.50hrs)		Q3 (9 to 11hrs)		Q4 (11.50 to 16hrs)		Q5 (\geq 16.50hrs)	
Adjusted	3,598	0.755 (0.475, 1.202)	0.237	0.966 (0.638, 1.461)	0.869	0.966 (0.643, 1.449)	0.866	0.954 (0.610, 1.492)	0.837
Model adjustments included child's gender, family type, parent/caregiver's educational level, and SIMD 2006/2009. Reference categories: 'low emotional symptoms', 'low conduct problems', 'low hyperactivity/inattention', 'low peer problems, and 'high prosocial behaviour'									

We further adjusted for binary SDQ score at age 4 (Table 5). Associations between screen time for 16.5 hours or more weekly and SDQ scores in conduct problems, hypertension/inattention and total difficulties regardless of the SDQ status at age 4 were significant (Table 5). Watching TV for 16.5 hours or more weekly was associated with a slight increase in great peer problems between ages 4 and 6 (OR 1.396, 95% CI 1.002 to 1.945). However, this association was not significantly strong. Emotional problems and low prosocial behaviour were not associated with the duration of screen time regardless of adjustment for SDQ at age 4.

Table 5

Longitudinal multivariate binary regression analysis of associations between binary SDQ scores (high vs low) and quintiles of screen time (hrs/week) for quintiles 2 to 5 relative to 1st Quintile (lowest time, \leq 6hrs) at age 6 years

		Q2 (6.50 to 8.50hrs)		Q3 (9 to 11hrs)		Q4 (11.50 to 16hrs)		Q5 highest time (\geq 16.50 hrs)	
Binary SDQ score (high/low)	N	OR (95%CI)	<i>P</i> value	OR (95%CI)	<i>P</i> value	OR (95%CI)	<i>P</i> value	OR (95%CI)	<i>P</i> value
High emotional symptoms	3,580	0.859 (0.587, 1.257)	0.435	1.048 (0.742,1.482)	0.789	0.765 (0.534, 1.097)	0.145	1.300 (0.911, 1.855)	0.149
High conduct problems	3,581	0.960 (0.729, 1.265)	0.774	1.072 (0.829, 1.387)	0.595	1.135 (0.883, 1.458)	0.323	1.448 (1.109,1.891)	0.006
High hypertension/Inattention	3,570	0.895 (0.669, 1.198)	0.456	0.907 (0.689, 1.195)	0.488	1.054 (0.809, 1.372)	0.698	1.390 (1.051, 1.837)	0.021
High peer problems	3,571	1.145 (0.813, 1.613)	0.438	1.061 (0.762, 1.476)	0.727	1.036 (0.750, 1.430)	0.832	1.396 (1.002, 1.945)	0.049
High total difficulties	3,539	0.846 (0.569, 1.258)	0.409	0.890 (0.613, 1.291)	0.540	1.121 (0.794, 1.582)	0.517	1.519 (1.067, 2.162)	0.020
Low prosocial behaviour	3,575	0.749 (0.471, 1.193)	0.223	0.952 (0.629, 1.442)	0.818	0.961 (0.640, 1.444)	0.849	0.949 (0.607, 1.483)	0.817
Model adjustments included child's gender, family type, parent/caregiver's educational level, SIMD 2006/2009 and binary SDQ score at age 4 years									

Discussion

We found that for age 4, watching TV for 18.5 hours or more per week (approximately 2 hrs 40 mins daily) was significantly associated with more significant behavioural problems in conduct problems and hyperactivity/inattention, peer problems, and lower prosocial behaviour. For age 6, 16.5 hours or more (approximately 2 hrs 20 mins daily) of watching TV was only associated with conduct problems and hyperactivity/inattention. Even after further adjustment for the SDQ status at age 4, only behavioural problems were significantly associated with greater than 16.5 hours weekly of TV watching time.

Our findings were in line with previous research on children aged 6 years, demonstrating associations between the use of mobile devices of 60 minutes or more and conduct problems and hyperactivity/inattention by using SDQ [20]. A previous longitudinal UK study using the UK Millennium Cohort Study (MCS), in which screen time of 3 hours or more daily predicted a slight increase in conduct problems, but not hyperactivity/inattention in children between 5 and 7 years of age [16]. Another longitudinal research on children aged 18–30 months illustrated the detrimental effects of high screen time on hyperactivity/inattention but not on conduct problems [15]. Although not all studies showed negative findings for both hyperactivity/inattention and conduct problems, these problems can be interpreted using the broader category of “externalising behaviours”. Some researchers suggested a three-factor model rather than the original five scales of the SDQ scale, namely an externalised scale combining conduct and hyperactivity subscales, an internalised scale consisting of emotional and peer problems subscales and the prosocial scale [28–30]. Therefore, with this binary category, high screen time was associated with externalising problems by allowing the SDQ to be compatible with other measurement tools [31–34].

Different screen time limits from other studies can be explained by differences in sample size, age group, outcome measures, and identified confounders. Compared to the MCS study in the UK, we did not include a larger number of participants and other predictors such as parenting, mother-child relationship, household chaos, and child characteristics in the analysis due to the limited availability of such data in the GUS study. Even so, our findings are meaningful as the GUS study solely focused on children in the Scottish environment, which makes our findings reflect more on the real state of circumstances of children and their families in Scotland.

The strengths of our study include the large sample size and a broad range of children’s developments such as emotional, behavioural and social domains. Few studies have examined children in the UK, especially in Scotland, which this study focused on. The effective sample sizes of both sweeps 4 and 6 were very close to the actual sample sizes, which means that the estimate can be close to the true population value with a good precision level (Table S6) [35]. Also, given that our multivariate binary regression models presented odds ratios with a relatively narrow 95% of CIs, our findings may be generalisable for most children in Scotland.

Even so, this study has several limitations. A very low proportion of non-white children was included in this cohort (age 4: 2.9%, age 6: 2.7%). In 2004, the number of non-white children was very low in Scotland compared to 2011 (age 0 to 15, White: Non-white = 94%: 6% in 2011) [36, 37]. Given that cultural backgrounds related to parenting can be associated with TV viewing time for children, findings might not be fully supported in the population of different backgrounds [38]. Despite a deliberate random selection process to ensure accurate representation, fewer from the most deprived areas agreed to participate in the GUS study, and this group has had the highest attrition over time. Non-response was higher amongst low Socioeconomic status (SES) families, lone parents, younger mothers, mothers who had not breastfed, families living in the more deprived area, and caretakers who did not join any groups for parents and children [35]. Hence, children aged 6 were biased slightly towards the less deprived, less troubled families. This tendency did not significantly affect the association analyses of this study but identifying the reasons for non-responses and reducing them would be needed to reflect the true population in any analysis of further studies. Although we adjusted for the SIMD, a risk of misclassification of individuals could exist. That is, deprived individuals could have been misclassified as “not deprived” or vice versa. Considering that deprivation of rural populations can be less homogeneous since rural data zones cover larger geographical areas than urban ones and comprise more socioeconomically dispersed populations than in urban areas, the SIMD reflecting deprived populations can be less accurate [39].

Furthermore, lower SES families could show more hostility and less responsibility in interactions with their children [40]. Therefore, children from lower SES families are likely to have negative emotionality, and this problem can be worsened by higher screen time. In this regard, future research should incorporate more accurate and precise data on SES as a potential factor.

In conclusion, our study found that TV viewing for more than 16 to 18 hours per week is associated with a high risk of children’s behavioural problems. Regardless of earlier developmental outcomes, there is an association between a higher amount of screen time and behavioural problems developing later. Further research is needed to incorporate more potential confounders and data over a longer followed-up period.

Declarations

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Author contributions

Conceptualization: BL,PW; Methodology: BL,PW; Formal analysis and investigation: BL; Writing - original draft preparation: BL; Writing - review and editing: BL; Supervision: PW

Ethics approval statement: This study was approved by the Usher ethics review committee at the University of Edinburgh, United Kingdom.

Potential conflicts of interest: All authors have nothing to disclose.

Data availability: All data relevant to the study are included in the article or uploaded as supplementary information.

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