

**Associations between screen time and mental health in childhood and adolescence:
Findings from the Millennium Cohort Study**

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Abstract

Objective: This study aimed to examine the curvilinear relationship between screen time and mental health in childhood and adolescence—thereby testing the digital Goldilocks hypothesis (Przybylski & Weinstein, 2017).

Methods: Multiple data sweeps were utilised from the Millennium Cohort Study, a nationally representative longitudinal study of children born in the UK in 2000-2002. Mental health was assessed using the Strengths and Difficulties Questionnaire, focusing on internalising and externalising problems. Screen time was measured in hours per day for TV viewing and video gaming. Separate ordinary least squares regression analyses were conducted for each combination of measures of mental health and screen time at age 5, 7, 11, 14 and 17—controlling for ethnicity, gender, and neighbourhood deprivation.

Results: A curvilinear relationship was found for age 14 (for both TV viewing and video gaming and for externalising and internalising problems), but findings across other ages were inconsistent. Data does indicate that both excessive screen time (7 hours or more), and none at all may adversely affect the mental health of children and adolescents.

Conclusions: This study provides some evidence in support of the Goldilocks hypothesis across childhood and adolescence. It also provides valuable insights into the nuanced association between screen time and mental health, emphasising the need for further investigation. The findings suggest the importance of balanced screen time to mitigate potential negative impacts on mental health. Continued research in this area is crucial to inform evidence-based guidelines and promote healthy screen time use among children and adolescents.

Keywords

Screen time, mental health, children, adolescents, sedentary behaviour

Introduction

With rising levels of sedentary behaviour, there has been growing interest in research examining sedentary behaviour and its link to health outcomes (Carson et al., 2016; Rollo et al., 2020). Sedentary behaviour is defined as any waking behaviour that requires low energy while sitting or lying down, including TV viewing and computer use (Tremblay et al., 2017). Furthermore, sedentary behaviour has received attention in research studying movement behaviours among children and adolescents where the focus has mainly been on physical activity (Chaput et al., 2014). In 2016, Canada developed the 24-h movement guidelines, which state that healthy children and adolescents should be achieving high levels of physical activity (an average of 60 min of moderate-to-vigorous physical activity per day across the week), keeping sedentary behaviours limited (including no more than 2 hours per day of screen time), and having adequate amounts of sleep (9-11 hours of sleep for children and 8-10 hours for adolescents; Tremblay et al., 2016). However, accelerometer-based research has shown that the majority (62%) of children and young people spend most of their waking hours (8.6 hours per day) being sedentary (Colley et al., 2011).

Due to the swift advancements in digital technologies and increase in availability, screen-based devices have become central to the modern lives of children and adolescents (Thomas et al., 2020). As a result of this, it has become increasingly difficult to follow the recommended guidelines of limiting sedentary screen time to less than 2 hours per day. Research globally reports that children and young people often do not meet this guideline including less than 50% in Canada (LeBlanc et al., 2015). Moreover, a study looking at the screen time of children and adolescents in 10 EU countries found that two thirds or more were exceeding the daily recommendation (Kovacs et al., 2022).

While some types of sedentary behaviour, for example, reading and completing homework have been linked with positive outcomes including better academic performance, higher levels of screen related sedentary behaviours can have detrimental effects on physical and mental health in children and young people (Chaput et al., 2020). A systematic review of 232 studies found that children and young people (aged 5-17 years) who spent more than 2 hours per day on screen time (specifically television viewing), were more likely to have lower scores on self-esteem and prosocial behaviour measures, unfavourable body composition, lower fitness levels, and a decline in academic achievement (Tremblay et al., 2011). A more recent meta-analysis found similar results (Rodriguez-Ayllon et al., 2019). Furthermore, Chaput et al. (2020) found higher levels of screen time (including TV viewing) to be linked

with poorer physical health, shorter sleep duration, and negative measures of adiposity; higher level of computer use was associated with poorer mental health, and finally, that higher levels of both TV watching and video gaming are linked with adverse results on measures of behavioural conduct and prosocial behaviour. The negative impact of higher screen time on mental health, in particular, is prominent in previous research. In their population-based study, Twenge and Campbell (2018) found that children and young people who spent more time on screens had significantly poorer psychological wellbeing than those who spent less time on screens daily. However, these associations were stronger for adolescents than children, while associations were consistent between low users and non-users.

Although existing research consistently identifies an adverse link between extensive screen time and mental health, the functional form of the association between screen time and mental health is unclear. The displacement hypothesis (Neuman, 1988), states that any screen time has adverse effects because it displaces time that could be spent on more favourable activities such as sleep and physical activity (Syväoja et al., 2018) or reading (Gentile et al., 2017). In contrast, the Goldilocks hypothesis predicts that the association between screen time and mental health is curvilinear: too much screen time displaces other activities, but moderate amounts of screen time is not inherently harmful and may even have benefits for young people (Przybylski & Weinstein, 2017). This hypothesis was further supported by the study of Brannigan et al. (2023) who found that no screen time as well as higher exposures of screen time are likely to have a negative impact on mental health. Moreover, 1-2 hours per day of engagement was found to be the right dose of screen exposure where psychiatric symptoms scores were the lowest. This is in line with the 24-h movement behaviours guidelines of no more than 2 hours per day of screen time.

Przybylski and Weinstein (2017) and Brannigan et al. (2023) have only evaluated the association between screen time and mental health in adolescence. Building on their work, the current study aims to further test the Goldilocks hypothesis by exploring the curvilinear relationship between screen time and mental health across both childhood and adolescence.

Methods

The study plan and analyses were pre-registered. The preregistration can be viewed at <https://osf.io/kbhwj>.

Participants and procedure

Data were utilised from the Millennium Cohort Study (MCS; UCL Social Research Institute, 2021), an ongoing and nationally representative longitudinal study of children born in the UK between 1st September 2000 and 11th January 2002. The sample consists of 18,552 families and 18,827 children at baseline, and there have been eight sweeps of data collection to date. Parent and child/adolescent questionnaires included measures of mental health and screen time from sweeps 3-7 (MCS 3 at 5 years old; MCS 4 at 7 years old; MCS 5 at 11 years old; MCS 6 at 14 years old; MCS 7 at 17 years old), therefore data from these sweeps were used.

Measure

Outcome variables. Mental health was measured using the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997). This is a commonly used measure of children and young people's emotional and behavioural problems. The SDQ is completed by a parent or caregiver or self-completed and is used to describe a child or young person's externalising and internalising problems. It has 5 scales of 5 items each: emotional problems (e.g. 'often complains of headaches; has many worries'), conduct problems (e.g. 'often fights with other children; often lies or cheats'), hyperactivity (e.g. 'restless, overactive; easily distracted'), peer problems (e.g. 'rather solitary, tends to play alone; picked on or bullied by other children'), and prosocial behaviour (e.g. 'helpful if someone is hurt; kind to younger children'). For the purpose of this study, and in line with Brannigan et al. (2023), internalising problems (i.e., emotional and peer problems) and externalising problems (i.e., conduct problems and hyperactivity) were used. A score of 0 is given if the answer is 'not true', 1 if 'somewhat true', and 2 if 'certainly true'. For each of the scales, the score will range from 0-10 and the internalising SDQ score is the sum of the emotional and peer problem items (total score 0-20). While the externalising SDQ score is the sum of the conduct problems and hyperactivity items (total score 0-20).

Predictor variables. Screen time was measured using two questions in relation to watching TV and computer use/video gaming (hours per day). For sweeps 3-5, these questions were completed by a parent, while for sweep 6-7, these questions were self-completed. Moreover, there were more response values in later sweeps. For instance, the response values for sweep 7 were: none, less than 30 min, 30 min to less than 1 hour, 1 hour to less than 2 hours, 2 hours to less than 3 hours, 3 hours to less than 5 hours, 5 hours to less than 7 hours, 7 hours to less than 10 hours, 10 hours or more. To make results comparable across sweeps, the more

detailed responses in sweeps 5-7 were recoded into the same categories that had been used for sweeps 3-4: none, less than 1 hour, 1 to less than 3 hours, 3 to less than 5 hours, 5 to less than 7 hours, and 7 hours or more.

Control variables: Consistent with Przybylski and Weinstein (2017), the following control variables were included: gender (male, female), ethnicity (White, Mixed, Indian, Pakistani or Bangladeshi, Black or Black British, other ethnic group), and multiple deprivation decile of the neighbourhood. Neighbourhood deprivation was measured in all MCS sweeps 1 to 6. The neighbourhood deprivation as measured in sweep 6 was used for the analyses on the association between screen time and mental health in sweep 7.

Multiple Imputation by Chained Equations were used, employing the Classification and Regression Tree algorithm to impute missing values (Burgette & Reiter, 2010; Van Buuren & Groothuis-Oudshoorn, 2011). Twenty imputations were created, and Rubin's rules were applied to calculate estimates and standard errors. This was computed using R (R Core Team, 2023) and the mice package (Van Buuren & Groothuis-Oudshoorn, 2011). The code is available at <https://osf.io/fkjca>.

Statistical Analysis

Twenty separate ordinary least squares (OLS) regressions were conducted for each combination of measures of mental health (externalising and internalising problems) and screen time (TV viewing and video gaming), for sweeps 3 to 7, with mental health as the outcome variable and screen time as the predictor variable. Ethnicity, gender, and neighbourhood deprivation were included as control variables.

Considering the ordinal response scale for its measures, screen time was treated as a categorical variable. Thereby, there were no restrictions of the functional form of the association between screen time and externalising and internalising problems. Screen time and ethnicity were treated as categorical variables, while the neighbourhood deprivation decile was treated as a continuous variable. All analyses were conducted using survey weights and adjusted standard errors to account for the sampling design, as recommended by the MCS guidelines (Ketende & Jones, 2011). Regression analyses were conducted using Stata version 16 (StataCorp, 2019)—the analysis code is available at <https://osf.io/fkjca>.

Results

The descriptive statistics for screen time (TV viewing and video gaming), mental health (externalising and internalising problems), ethnicity, gender, and neighbourhood deprivation are reported in Table 1. An association between screen time and mental health was identified, after adjusting for neighbourhood deprivation, gender, and ethnicity (Figure 1 and 2).

At ages 5, 7, and 11, playing less than 1 hour of video games was associated with the lowest externalising and internalising problems in children. Externalising and internalising problems of children with less than 1 hour of videogames were between 0.3 and 0.5 scale points lower than those of children playing no video games (see regression coefficients in Supplementary Tables 1-4). These differences were statistically significant. There was a similar tendency for video gaming at age 14, although the difference between children with none and less than 1 hour of video gaming was small and not statistically significant. At age 17, a monotonic increase in externalising and internalising problems was observed with increase in time playing video games.

For time spent watching TV among children (age 5, 7, or 11), there was no clear evidence for a Goldilocks point. Instead, there were comparable, and relatively low, levels of externalising and internalising problems for children who watched either no TV or watched TV for up to one hour per day. Also, children watching between 1-3 hours of TV per day did not seem to fare substantially worse in terms of externalising and internalising problems. However, children watching TV for 3-5 hours per day had substantially higher externalising and internalising problems. The difference between 1-3h and 3-5h was more than 0.5 scale points at ages 5, 7, and 11 and for both internalising and externalising problems. At age 14, young people watching no TV or watching TV for 7 or more hours per day had substantially higher externalising and internalising problems. For adolescents reporting levels of TV viewing out with these extremes had similar levels of externalising and internalising problems. At age 17, adolescents watching between 1-3 hours of TV per day had the lowest externalising and internalising problems, and those reporting either no TV consumption or very high TV consumption had the highest externalising and internalising problems.

Discussion

Given its prominent presence in children's and adolescents' lives, screen time has become a pressing public health issue. The purpose of this study was to further test the Goldilocks hypothesis, and to explore whether there is a curvilinear relationship between screen time and

mental health in both childhood and adolescence. To do this, the study aimed to replicate the findings from the original study by Przybylski and Weinstein (2017) and a previous replication study (Brannigan et al., 2023)—both of which focused only on adolescents.

Although the findings yielded inconsistencies regarding the Goldilocks hypothesis, the results provide further evidence for links between excessive screen time and poorer mental health. Significant nonlinear associations between screen time and externalising and internalising problems were identified. In many cases, the lowest externalising and internalising problems were observed at less than 1 hour and 1-3 hours per day of screen time, but this was not consistent across types of screen time and age. Although this partly supports public health recommendations of no more than 2 hours per day of recreational screen time for children and adolescents (Tremblay, et al., 2016; Loo et al., 2022), more research is needed to determine optimal amounts of recreational screen time across age groups.

At ages 5 and 7, both externalising and internalising problems were lowest in children who engaged in TV viewing or video gaming for less than 1 hour per day, and higher when children did not engage in TV viewing or video gaming at all. Poorer mental health symptoms were also significantly higher when engagement in screen time activities was 3 hours per day or more. These patterns are similar to those found in the studies by Przybylski and Weinstein (2017), and Brannigan et al. (2023). At age 11, both internalising and externalising problems were significantly worse when engaging in screen time for more than 3 hours per day and mental health problems were lowest when engaging in screen time for less than 1 hour per day, except at age 14, the lowest levels of externalising problems were identified among those engaging in less than 1 hour per day of video gaming and 1-3 hours per day of TV viewing. Similarly, the lowest levels of internalising problems were observed within the same time frame.

For 14-year-olds, both no TV time altogether and engaging in TV viewing for 7 hours or more per day were associated with significantly elevated levels of externalising and internalising problems. The absence of TV time exhibited nearly comparable adverse effects on mental health as excessive TV viewing exceeding 7 hours or more daily. In relation to video gaming, some Goldilocks points were observed at less than 1 hour at 14 years old, suggesting a curvilinear relationship. However, the difference between 14-year-olds with none and less than 1 hour of video gaming is small and not statistically significant. Furthermore, the monotonic increase in externalising and internalising problems with increasing time playing video games may be explained by the displacement hypothesis

(Neuman, 1988). Excessive gaming can displace healthier activities such as sleeping, studying or physical activity, which in turn may impact overall health (Peracchia & Curcio, 2018). At age 17, there is a shift where internalising problems are higher than externalising problems for both TV viewing and video gaming. With the available data, it was not possible to investigate patterns of bedtime screen use, but this may drive the relationship between screen time and internalising problems further (Tang et al., 2021) and should be taken into account in future research.

Strengths and limitations

The MCS provides data on screen time and mental health in children and adolescents in the UK with a large nationally representative sample allowing control for covariates. However, due to the multidisciplinary nature of the MCS, some measures (specifically, screen time) lack depth and high-level detail (Connelly & Platt, 2014). For example, video gaming is measured by hours spent on “using a computer or playing electronic games outside school lessons”, which does not take into account the content of screen time, or time of day. Sanders et al. (2023) argues that the content being accessed during screen time, may be of pivotal importance in determining potential benefits or harm. Weekend data were also not included. Furthermore, it does not consider the possibility of multiple screen use simultaneously, which can further increase risks of mental health problems. Arundell et al. (2019) refers to this concept as “screen-stacking”.

Kaye et al. (2020) also highlighted that users’ estimated reports may be biased, particularly within parental reports of children’s estimated screen time due to social desirability bias. Future research should aim to focus on the use of screen time measures that take into account content, context, duration and quality of screen time, given the diverse range of screen-based activities and contexts that may yield different outcomes (Kaye et al., 2020). Moreover, the cross-sectional nature of the analysis in this study does not allow for the establishment of causal mechanisms (Parkes et al., 2013). Further longitudinal investigations are therefore recommended to explore the influence of screen time on mental health and establish causal mechanisms.

Despite the limitations outlined, this study possesses several strengths that contribute significantly to the understanding of the relationship between screen time and mental health. One of the notable strengths of our study is the inclusion of data of participants as young as 5 years old, in contrast to the previous studies on the Goldilocks hypothesis, which only

focused on adolescents (Przybylski & Weinstein, 2017; Brannigan et al., 2023). By including participants from childhood to adolescence, it was possible to highlight trends and changes in externalising and internalising scores in relation to screen time across different developmental stages. Furthermore, the measure of time on screen engagement in this study was similar to the study by Brannigan et al. (2023), where time was measured incrementally rather than continuously as in the original study by Przybylski and Weinstein (2017).

Unlike previous studies, the screen time variable was not converted into a continuous measure to avoid mis-specifying the functional form of the association between screen time and mental health (Liddell & Krusche, 2018). This approach may explain the greater complexity in our findings compared to earlier research. Our study benefits from this flexibility, which may better capture the nuanced nature of these associations. Future research should explore different types of screen time to identify potentially varying Goldilocks points and employ a more flexible statistical approach to accurately reflect the complex nature of these relationships.

Conclusions

As screen time among children and adolescents continues to rise—exceeding the recommendation of 2 hours per day of recreational screen time in 70% of cases (Kovacs et al., 2022)—understanding the relationship between screen time and mental health is becoming increasingly important. This study provides evidence on this relationship in a large and nationally representative sample of UK children and adolescents, underpinning that this relationship is non-linear. While a consistent Goldilocks point was not identified, this study provides valuable insights into the complex relationship between screen time and mental health. Specifically, it suggests that screen time exceeding 3 hours per day appears to be detrimental for children ages 11 or younger, as evidenced by significant increases in mental health outcomes at this threshold. Such findings advocate for a more nuanced approach to screen time guidelines and highlight the need for continued research in this area. The findings of this study do, however, support the notion that both prolonged exposure to screen time and none at all can have adverse effects on the mental health of children and adolescents. These findings underscore the importance of balanced screen time to minimise the risk of adverse effects on mental health. Ongoing research is necessary for guiding evidence-based recommendations and fostering healthy screen time habits among children and adolescents.

Data availability

The Millenium Cohort Study data used in this study can be accessed through the UK Data Service (<http://doi.org/10.5255/UKDA-Series-2000031>). The code used for the analysis is available on the Open Science Framework (<https://osf.io/fkjca>).

Author contributions

Maria Loban: Methodology, Writing – Original Draft, Writing – Review & Editing. Jascha Dräger: Conceptualisation, Methodology, Formal Analysis, Visualisation, Writing – Review & Editing. Farid Bardid: Conceptualisation, Methodology, Writing – Original Draft, Writing – Review & Editing, Project Management.

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Table 1. Means for externalising problems, internalising problems, and neighbourhood deprivation, and percentages for TV (in hours), video games (in hours), ethnicity, and gender. Multiple Imputed data (m=20), weighted with survey weights.

		Age 5	Age 7	Age 11	Age 14	Age 17
TV	None	1.974	1.825	1.439	1.245	1.559
	Less than 0.5	19.289	17.474	14.273	3.399	3.634
	0.5 to 1				7.892	6.768
	1 to 2	63.851	64.784	43.174	19.607	17.002
	2 to 3			24.598	23.523	19.565
	3 to 5	9.697	11.126	11.551	23.132	22.811
	5 to 7	2.064	2.143	2.149	11.599	13.416
	7 to 10	3.124	2.649	2.817	9.605	6.741
	10+					8.504
Video Games	None	32.684	12.416	14.460	17.356	21.186
	Less than 0.5	44.566	51.905	38.139	12.786	14.072
	0.5 to 1				11.131	10.171
	1 to 2	19.862	31.577	30.869	15.248	13.150
	2 to 3			9.990	13.974	10.648
	3 to 5	1.678	2.961	4.542	13.481	10.168
	5 to 7	.548	.625	.784	7.237	7.788
	7 to 10	.663	.516	1.216	8.787	4.494
	10+					8.323

Externalising problems	Mean	4.818	4.899	4.737	4.828	3.904
	(SD)	(3.436)	(3.660)	(3.709)	(3.812)	(3.473)
Internalising problems	Mean	2.523	2.842	3.370	4.019	4.019
	(SD)	(2.538)	(2.856)	(3.276)	(3.556)	(3.642)
Neighbourhood Deprivation	Mean	5.480	5.418	5.387	5.257	-
	(SD)	(2.956)	(2.952)	(2.945)	(2.952)	
Ethnicity	White	86.692	85.406	84.456	83.715	86.251
	Mixed	3.277	3.328	3.524	3.609	3.572
	Indian	1.820	1.920	2.018	2.081	1.737
	Pakistani / Bangladeshi	4.155	4.687	4.995	4.871	3.818
	Black or Black British	2.826	3.316	3.550	4.149	3.208
	Other	1.230	1.343	1.457	1.576	1.414
Gender	Female	48.963	48.641	48.416	47.728	49.068
	Male	51.037	51.359	51.584	52.272	50.932
N		15431	14013	13447	11859	10734

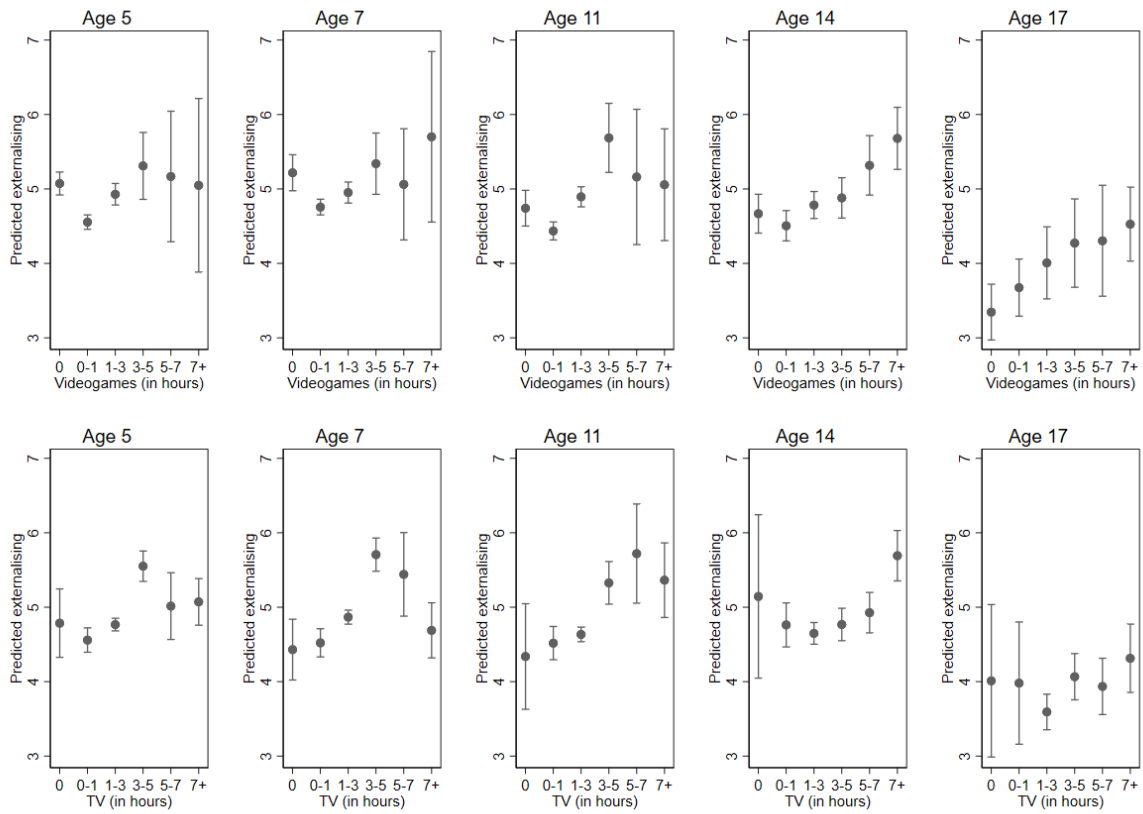


Figure 1. Predicted externalising problems by screen time at different ages. Point estimates and 95% confidence intervals based on linear regressions. Multiple imputed and weighted. $N_{\text{Age } 5}=15431$, $N_{\text{Age } 7}=14013$, $N_{\text{Age } 11}=13447$, $N_{\text{Age } 14}=11859$, $N_{\text{Age } 17}=10734$.

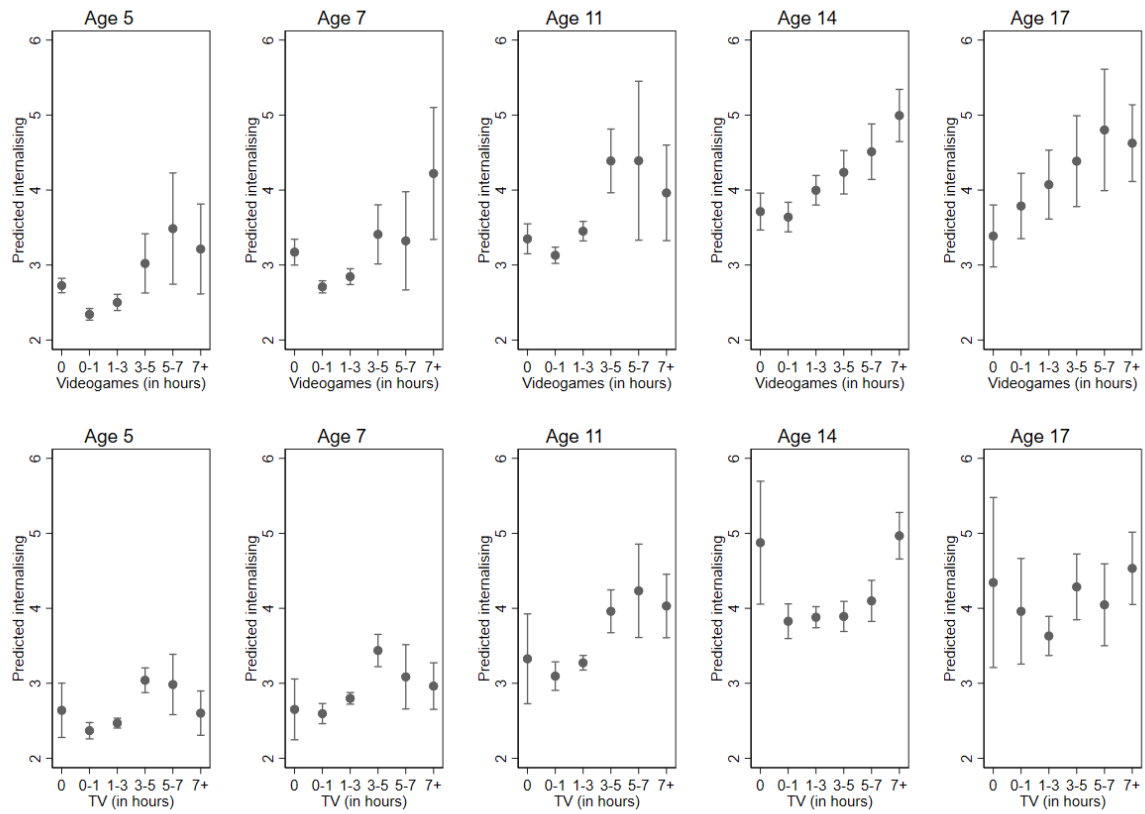


Figure 2. Predicted internalising problems by screen time at different ages. Point estimates and 95% confidence intervals based on linear regressions. Multiple imputed and weighted. $N_{\text{Age } 5}=15431$, $N_{\text{Age } 7-\text{Age } 11}=13447$, $N_{\text{Age } 14}=11859$, $N_{\text{Age } 17}=10734$.

Supplementary Table 1. Coefficients of OLS regression of externalising problems on time spent on video games and control variables. *p*-values in parentheses * *p* < 0.05, ** *p* < 0.01, *** *p* < 0.001.

	Age 5	Age 7	Age 11	Age 14	Age 17
Video Games					
0 hours	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>
0-1 hours	-0.518*** (0.000)	-0.461*** (0.000)	-0.306* (0.016)	-0.162 (0.243)	0.329 (0.203)
1-3 hours	-0.144 (0.168)	-0.266 (0.056)	0.153 (0.272)	0.116 (0.474)	0.661* (0.037)
3-5 hours	0.236 (0.305)	0.122 (0.598)	0.945*** (0.000)	0.212 (0.313)	0.927* (0.016)
5-7 hours	0.094 (0.835)	-0.156 (0.689)	0.420 (0.377)	0.649** (0.009)	0.958* (0.033)
7+ hours	-0.024 (0.968)	0.484 (0.412)	0.315 (0.436)	1.012*** (0.000)	1.181*** (0.001)
Ethnicity					
White	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>
Mixed	0.198 (0.246)	-0.015 (0.948)	0.193 (0.421)	0.027 (0.912)	0.008 (0.983)
Indian	-0.253	-0.134	-0.466	-0.383	-0.664**

	(0.196)	(0.599)	(0.083)	(0.441)	(0.009)
Pakistani and Bangladeshi	0.197	-0.119	-0.481***	-0.528**	-0.092
	(0.275)	(0.480)	(0.001)	(0.001)	(0.701)
Black or Black British	-0.476*	-0.827***	-0.907**	-0.842***	-0.452
	(0.015)	(0.000)	(0.001)	(0.000)	(0.128)
Other	-0.200	-0.565	-0.391	-0.279	-0.195
	(0.469)	(0.119)	(0.183)	(0.456)	(0.770)
Gender					
Girl	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>
Boy	0.972***	1.230***	1.129***	0.899***	0.559**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.005)
Neighbourhood Deprivation	-0.214***	-0.230***	-0.223***	-0.255***	-0.178***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	4.784***	4.644***	4.296***	4.713***	3.497***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
N	15431	14013	13447	11859	10734

Supplementary Table 2. Coefficients of OLS regression of externalising problems on time spent watching TV and control variables.

	Age 5	Age 7	Age 11	Age 14	Age 17
TV					
0 hours	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>
0-1 hours	-0.227 (0.330)	0.091 (0.696)	0.180 (0.622)	-0.383 (0.500)	-0.031 (0.963)
1-3 hours	-0.019 (0.935)	0.437* (0.040)	0.297 (0.411)	-0.496 (0.376)	-0.419 (0.421)
3-5 hours	0.765** (0.004)	1.277*** (0.000)	0.989** (0.010)	-0.377 (0.510)	0.055 (0.920)
5-7 hours	0.229 (0.508)	1.011** (0.006)	1.382** (0.005)	-0.218 (0.704)	-0.076 (0.895)
7+ hours	0.286 (0.287)	0.259 (0.377)	1.025* (0.014)	0.547 (0.354)	0.302 (0.613)
Ethnicity					
White	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>
Mixed	0.203 (0.229)	-0.011 (0.962)	0.195 (0.426)	0.002 (0.993)	-0.024 (0.954)
Indian	-0.286 (0.147)	-0.173 (0.481)	-0.477 (0.070)	-0.433 (0.384)	-0.748** (0.006)
Pakistani and Bangladeshi	0.233 (0.199)	-0.075 (0.641)	-0.493*** (0.000)	-0.577*** (0.000)	-0.129 (0.598)
Black or Black British	-0.442* (0.287)	-0.772*** (0.000)	-0.916** (0.014)	-0.977*** (0.000)	-0.536 (0.613)

	(0.026)	(0.000)	(0.001)	(0.000)	(0.074)
Other	-0.210	-0.526	-0.383	-0.327	-0.276
	(0.442)	(0.146)	(0.201)	(0.384)	(0.692)
Gender					
Girl	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>
Boy	0.956***	1.234***	1.271***	1.165***	0.965***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Neighbourhood Deprivation	-0.207***	-0.225***	-0.225***	-0.260***	-0.185***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	4.481***	3.824***	3.687***	4.818***	3.593***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
N	15431	14013	13447	11859	10734

p-values in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Supplementary Table 3. Coefficients of OLS regression of internalising problems on time spent on video games and control variables.

	Age 5	Age 7	Age 11	Age 14	Age 17
Video Games					
0 hours	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>
0-1 hours	-0.384*** (0.000)	-0.463*** (0.000)	-0.220* (0.050)	-0.073 (0.621)	0.400 (0.187)
1-3 hours	-0.225** (0.002)	-0.327** (0.002)	0.102 (0.379)	0.284 (0.093)	0.685* (0.041)
3-5 hours	0.296 (0.156)	0.237 (0.284)	1.039*** (0.000)	0.524* (0.013)	0.997* (0.015)
5-7 hours	0.760* (0.047)	0.151 (0.654)	1.042 (0.059)	0.799*** (0.001)	1.413** (0.005)
7+ hours	0.488 (0.106)	1.049* (0.020)	0.613 (0.070)	1.282*** (0.000)	1.237*** (0.001)
Ethnicity					
White	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>
Mixed	0.237 (0.099)	0.330 (0.073)	0.198 (0.393)	0.099 (0.675)	-0.403 (0.236)
Indian	0.503** (0.008)	0.320 (0.178)	-0.239 (0.265)	0.154 (0.818)	-0.395 (0.203)
Pakistani and Bangladeshi	1.143*** (0.000)	0.841*** (0.000)	0.288* (0.040)	0.214 (0.129)	-0.320 (0.212)
Black or Black British	0.205	0.048	-0.479* (0.070)	-0.488* (0.000)	-0.277 (0.001)

	(0.210)	(0.759)	(0.033)	(0.020)	(0.598)
Other	0.975***	0.427	0.350	0.189	-0.015
	(0.000)	(0.129)	(0.338)	(0.569)	(0.985)
Gender					
Girl	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>
Boy	0.104*	0.156**	0.004	-0.655***	-1.161***
	(0.011)	(0.005)	(0.955)	(0.000)	(0.000)
Neighbourhood Deprivation					
	-0.135***	-0.146***	-0.141***	-0.189***	-0.183***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	3.227***	3.661***	4.099***	5.705***	6.173***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
N	15431	14013	13447	11859	10734

p-values in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

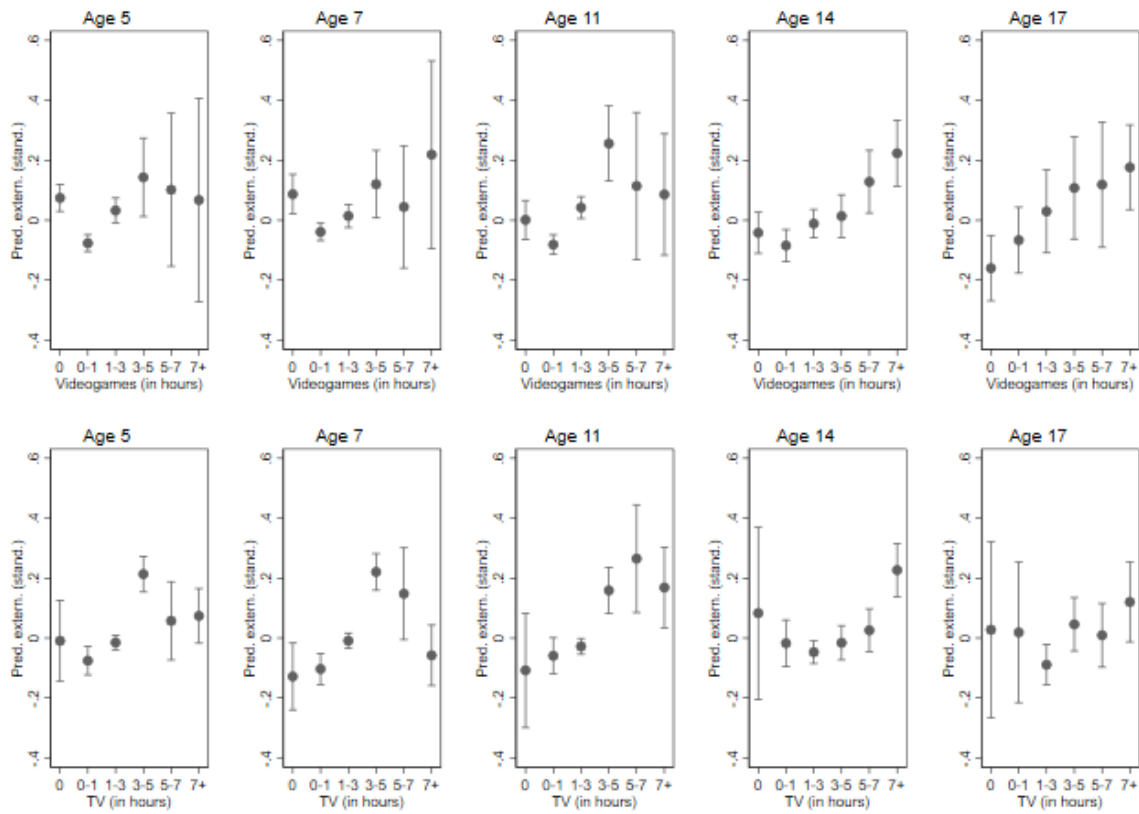
Supplementary Table 4. Coefficients of OLS regression of internalising problems on time spent watching TV and control variables.

	Age 5	Age 7	Age 11	Age 14	Age 17
TV					
0 hours	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>
0-1 hours	-0.272 (0.154)	-0.056 (0.787)	-0.231 (0.457)	-1.047* (0.017)	-0.384 (0.578)
1-3 hours	-0.171 (0.353)	0.147 (0.478)	-0.053 (0.863)	-0.994* (0.020)	-0.713 (0.226)
3-5 hours	0.401 (0.053)	0.785** (0.001)	0.633 (0.064)	-0.983* (0.023)	-0.059 (0.927)
5-7 hours	0.344 (0.202)	0.434 (0.144)	0.906* (0.040)	-0.776 (0.076)	-0.297 (0.637)
7+ hours	-0.038 (0.879)	0.311 (0.238)	0.704* (0.038)	0.093 (0.837)	0.189 (0.757)
Ethnicity					
White	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>
Mixed	0.242 (0.094)	0.342 (0.062)	0.195 (0.401)	0.073 (0.757)	-0.437 (0.205)
Indian	0.473* (0.012)	0.292 (0.220)	-0.252 (0.244)	0.082 (0.902)	-0.486 (0.105)
Pakistani and Bangladeshi	1.164*** (0.000)	0.882*** (0.000)	0.271 (0.053)	0.145 (0.304)	-0.359 (0.161)
Black or Black British	0.220	0.076	-0.487* (0.038)	-0.653** (0.023)	-0.381 (0.757)

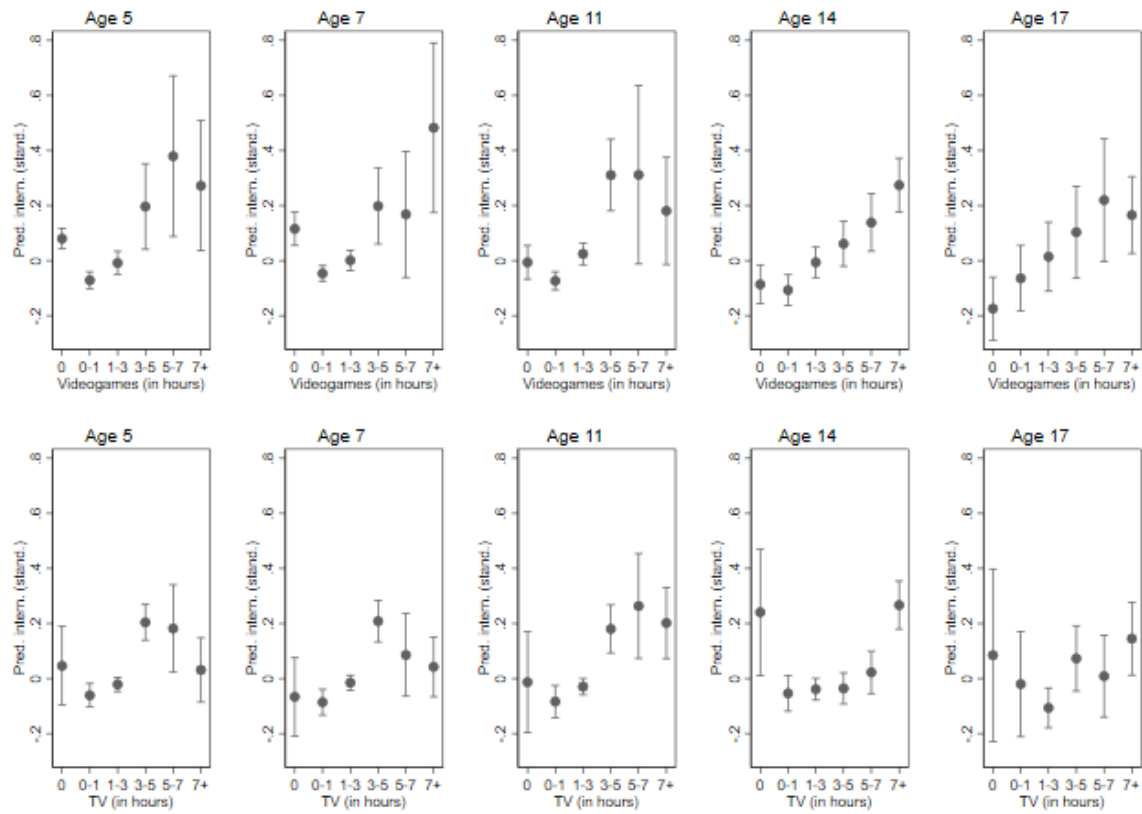
	(0.199)	(0.637)	(0.029)	(0.002)	(0.464)
Other Ethnic group	0.960***	0.456	0.348	0.125	-0.129
	(0.000)	(0.113)	(0.344)	(0.709)	(0.878)
Gender					
Girl	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>
Boy	0.090*	0.165**	0.133	-0.300***	-0.704***
	(0.031)	(0.004)	(0.084)	(0.001)	(0.000)
Neighbourhood Deprivation	-0.130***	-0.145***	-0.143***	-0.196***	-0.190***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	3.133***	3.123***	3.890***	6.375***	6.484***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
N	15431	14013	13447	11859	10734

p-values in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$



Supplementary Figure 1. Predicted externalising problems (standardised) by screen time at different ages. Point estimates and 95% confidence intervals based on linear regressions. Multiple imputed and weighted. $N_{\text{Age } 5}=15431$, $N_{\text{Age } 7}=14013$, $N_{\text{Age } 11}=13447$, $N_{\text{Age } 14}=11859$, $N_{\text{Age } 17}=10734$.



Supplementary Figure 2. Predicted internalising problems (standardised) by screen time at different ages. Point estimates and 95% confidence intervals based on linear regressions. Multiple imputed and weighted. $N_{Age5}=15431$, $N_{Age7}=14013$, $N_{Age11}=13447$, $N_{Age14}=11859$, $N_{Age17}=10734$.