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Screen media use by Portuguese children in 2009 and 2016: a repeated cross-sectional study

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Abstract

Background: Few studies have examined how access to mobile media is disrupting more traditional forms of media use.

Aim: Examine screen-time in 2009/10 and 2016/17 among children aged 3 to 6 years and assess potential socio-economic determinants of adherence to screen-time recommendations.

Method: Two independent cross-sectional studies included 6874 Portuguese children. Screen-time (including television, computer, tablet and smartphone) and proxy measures to calculate socioeconomic position (SEP) were parent-reported using a standardized questionnaire. Screen-time and adherence to screen-time recommendation were calculated for both periods.

Determinants of excessive screen-time were identified using adjusted logistic regression models.

Results: In 2009/10 screen-time averaged 107min/day for preschool children and 149min/day for school-aged children. In 2016/17 values were 142min/day and 173min/day, respectively. Screen-time allocated to television was the highest, independently of children's age. In 2016/17, mobile media use was common among preschool (37min/day) and school-aged children (43min/day). Exceeding the recommended screen-time was more prevalent in boys than girls (adjusted odds ratio [aOR] between 1.02-1.59) and in children whose parents had lower education levels or were unemployed (aOR between 1.00-2.23).

Conclusion: Screen-time was high among preschool children, emphasizing the need for earlier interventions, particularly among those from lower-SEP who had higher risk of exceeding the screen-time recommendations.

Keywords: Childhood; Screen-time; Mobile devices; Inequalities; Socioeconomic position

Introduction

A growing proportion of children's leisure time seems to be spent with screens via increasingly prevalent and accessible mobile devices (Rideout 2017; Kabali et al. 2015), raising concerns about the effect of screen-time on children's health and development (Stiglic and Viner 2019).

Devices can be used for entertainment, social support, or access to educational materials for children but there is evidence that excessive screen-time is associated with obesity and deleterious effects on cognitive and socio-emotional development (Pagani et al. 2013; Cheung et al. 2017; Robinson et al. 2017; Tomopoulos et al. 2010; Anderson and Subrahmanyam 2017; Madigan et al. 2019). Nevertheless, the great majority of findings have been related to television screen-time and data on other forms of screen-time, including computer use, gaming consoles, tablets and smartphones, have been sparse; other have argued that screen-based digital media may yield health, social and cognitive benefits (Stiglic and Viner 2019).

In the last two decades, mobile media have become a nearly universal part of the children's media landscape (Rideout 2017). In 2015, Kabali et al. found that by age 4, three out of four children living in the US had their own mobile devices and Chen and Adler (2019) concluded that the average screen exposure in young North American children has increased significantly from 1997 to 2014 because of the introduction of mobile devices.

The American Academy of Pediatrics (AAP 2018) and the World Health Organization (WHO 2019) recommend a limit of one hour/day for 2-5 year old children and a limit of 2 hours/day for children aged 5 to 17 years. Despite these recommendations, most children do not meet screen-time guidelines (CCM 2016; Rideout 2017; Madigan et al. 2020), including in Portugal where the proportion of children watching more than 2h of TV was almost 30% and 75% on weekdays and weekends, respectively (Jago et al. 2012). Children's screen-time seems to be associated with their socioeconomic position (SEP) but this association differs across countries. In high-income countries, children from a lower-SEP family have more screen-based sedentary time (Gong et al. 2019), whereas the pattern is the opposite in low-income countries (Mielke et al. 2017). Also, inconsistencies in whether parental education level and the presence of siblings (Kourlaba et al. 2009; Lee et al. 2009; Carson and Janssen 2012; Chandra et al. 2016) are associated with higher screen-time suggest that remaining determinants require further examination.

Ignoring socioeconomic disparities may lead to erroneous estimation of children's potential needs for targeted interventions and increased risk of sedentary-related problems. However,

there is limited research about the use of these newer devices and their contribution towards health-related screen-time guidelines (Thomas et al. 2020). Also, growing evidence indicates that early childhood is an important time to acquired lifelong media habits (Thorp et al. 2011). This time is also a period of enormous brain plasticity, when experiences exert profound influences on social, cognitive, and emotional development (Jimenez et al. 2016).

As such, this study aims to contribute to the sparse international data on young children's screen-time before and after commonly used mobile devices were widely available, by using two independent cross-sectional studies carried on 2009/10 and 2016/17. Our objectives for the two observed periods are: 1) to assess preschool and school-aged children's screen-time in different media devices; 2) to examine adherence to the screen-time recommendations among children; and 3) to identify socioeconomic characteristics associated with non-adherence to those recommendations.

Materials and methods

Sample

The present study used data from two independent cross-sectional projects, namely: the "Portuguese Prevalence Study of Obesity in Childhood" which was conducted between March 2009 and January 2010; and the "Inequalities in Childhood Obesity: the impact of the socioeconomic crisis in Portugal from 2009 to 2015" project, conducted between November 2016 and April 2017. Sampling procedures were the same in both projects. In brief, the sampling in 2009/10 was based on a proportionate stratified random design that took into account the number of children by age and in each district and was designed to provide a nationally representative survey of children in Portugal. In each district, schools were randomly selected and then year groups were selected within schools, with a total of 17 509 assessed at that time (Jago et al., 2012; Stamatakis et al. 2013).

In 2016/17, schools participating in the 2009/10 project from the districts of Coimbra, Lisbon and Porto were selected (each district covers a large geographical area encompassing several cities). A total of 13 787 invitations were sent (i.e., to all the students enrolled) and 8472

preschool and primary school-aged children were recruited from 118 schools of the three districts (participation rates were 58% in Coimbra, 67% in Lisbon and 60% in Porto).

The analysis conducted in the present study was restricted to the sample of children aged 3.0 to 6.9 years enrolled in public and private preschools and primary schools in Coimbra, Porto and Lisbon in both 2009/10 and 2016/17. Therefore, the sample analysed in this study is comprised by 3080 children (48.7% boys; 5.18 ± 1.14 years) from 2009/10 and 3797 children (50.9% boys; 5.41 ± 1.07 years) from 2016/17.

Ethical approval and informed consent

The 2009/10 study protocol was approved by the Portuguese Commission for Data Protection which requires anonymity and non-transmissibility of data, corroborated by the Direcção Geral de Inovação e Desenvolvimento Curricular (DGIDC). In 2016/17, the study was approved by Direcção Geral do Ensino (Portuguese Ministry of Education) and Comissão Nacional de Protecção de Dados (CNPd, the Portuguese Data Protection Authority; authorization number 745/2017). All procedures were in accordance with the guidelines laid down in the Declaration of Helsinki 1975, revised Hong Kong 1989. Prior to data collection, written informed consent was obtained from children's parents.

Screen-viewing variables

In both projects, parents were asked to complete a mailed paper-based questionnaire that assessed the screen-viewing time of the child who was recruited into the study. In 2009/10 and in 2016/17, parents were asked to report the average number of hours/day that the child spent watching television, using a computer, and playing electronic games on a weekday, Saturday and Sunday. In 2016/17 the questionnaire included a question on the time spent using a tablet and a smartphone on a weekday, Saturday and Sunday. Response options for all questions were none, <1 hour, 1 hour, 2 hours, 3 hours, 4 hours, and >4 hours/day. No distinction were made between school- and non-school-related screen-time and the use of media devices at school vs. at home.

In 2009/10, total screen-time included the time spent while watching television, using a computer and playing electronic games. In 2016/17, total screen-time was defined as in 2009/10

plus the time spent using smartphones and tablets. To estimate mean screen-time, the original categories (none, ≤ 1 hour, < 1 hour, 1 hour, 2 hours, 3 hours, 4 hours, and > 4 hours) were recoded into a proxy continuous variable: none was coded as 0, ≤ 1 hour as 30 minutes, 1 hour as 60 minutes, 2 hours as 120 minutes, and so on. The scores for Saturday and Sunday were combined and used to create a weekend screen-time.

To obtain a measure of screen-time that was broadly consistent with the AAP and WHO recommendations (AAP 2018; WHO 2019), the data was recoded into two groups: those meeting screen-time recommendations (< 60 minutes/day for children aged 3 to 4 years; < 120 minutes/day for children aged 5 and 6-year-old) and those exceeding the screen-time recommendations (≥ 60 minutes/day for children aged 3 to 4 years; ≥ 120 minutes/day for children aged 5 and 6-year-old).

Socioeconomic position and other variables

Father and mother's education and work status were used as indicators of SEP. Father and mother's work status were assessed with the question: "are you currently working" and categorized as "yes" (i.e., currently working) and "no" (i.e., unemployed, does not included retired). Father and mother's education were based on the Portuguese Educational System and according the years of school completed, as follows: lower (less than or equal to 9 years of school completed), medium (from 10 to 12 years of school completed), and high (university degree). Similar procedures have been used in the Portuguese context (Mota et al. 2011; Machado-Rodrigues et al. 2017), since Portugal does not have any official categories.

Parents were asked if the child had any brothers or sisters and how many. The number of siblings was categorized into three groups: none (only child), one, or two or more.

Statistical Analysis

To prevent over-influential outliers from affecting the analyses, values in the time-use variables that were greater than the 99th percentile of the variable distribution were top-coded (i.e., substituted with the value of the 99th percentile). Sample characteristics were analysed separately according to the observation period and children's age. Screen-time (means minutes/day and standard errors) was evaluated using descriptive statistics. Prevalence of

children following (or not) screen-time recommendations was calculated; chi-square tests were run to identify statistically significant differences between periods and according to children's age. Finally, logistic regression models were used to examine whether child's sex, number of siblings, father and mother's education and work status predicted whether the child exceeded the screen-time recommendations on a weekday or weekend day, in 2009/10 and 2016/17.

Significance was set at 5% and SPSS 21.0 (SPSS Inc., Chicago, Illinois) was used.

Results

In 2016/17, the majority of parents had a high education level while a low level of education was more prevalent among fathers in 2009/10 ($p < 0.001$). Most fathers and mothers were working, independently of the year observed. Descriptive statistics are presented in Table 1.

Daily screen-time was higher on weekend days than on weekdays and in school-aged children compared with preschool aged children. Also, total screen-time (including all the screen media devices) among 3-6 years old children was higher in 2016/17 than in 2009/10. In 2009/10, the mean daily screen-time was 76min/day (standard error [SE]: 1.22) and 158min/day (SE: 2.12) on weekdays and weekends, respectively. In 2016/17, children spent an average of 95min/day (SE: 1.56) on weekdays and 196min/day (SE: 2.44) on weekends using screen media devices (Figure 1).

The time allocated to television was the highest; in 2009/10, children aged 3-4 years and 5-6 years watched television for 95min/day (SE:1.83) and 110min/day (SE: 1.54), respectively; in 2016/17, children aged 3 and 4 years and 5 to 6 years watched television for 94min/day (SE: 1.64) and 105min/day (SE: 1.18), respectively. By 2016/17, mobile devices (i.e., tablet and smartphone) were the second screen-media more used by preschool children (37min/day; SE: 1.58) and school-aged children (43min/day; SE: 1.18).

The proportions of children whose daily screen-time exceeded the recommended maximum for age were largest for children aged 3 to 4 years (in 2009/10: 72.1%; in 2016/17: 87.8%) compared with 5 to 6 years old children (62.7% and 66.3% in 2009/10 and 2016/17, respectively) (Figure 2). Factors associated with non-adherence to screen-time recommendations in the logistic regression analysis was similar between age groups. Overall,

father and mother being unemployed (vs. employed) and father with lower or middle education level (vs. higher education level) increased the odds of children aged 3 to 4 years exceeding the daily recommendation for screen-time. Among children aged 5 to 6 years old, being a boy (vs. a girl), father and mother being unemployed (vs. employed) and father and mother with lower or middle education level (vs. higher education level) significantly increased the odds of non-adherence to screen-time recommendations (Table 2).

Discussion

To our knowledge, this is the first study that assessed the temporal patterns of screen-time in Portuguese children before and after the widespread use of new mobile devices. The present study is also one of the few regarding the use of mobile devices by young children. Overall, in 2016/17, 3 to 4 years old children spent an average of 92 minutes during weekdays and 167 minutes on weekend days using screen media devices (more 23 and 40min/day, respectively, compared with children of the same age in 2009/10). Among children aged 5 to 6 years old, the differences between daily screen-time in 2009/10 and in 2016/17 were of more 15 minutes on weekdays and 28 minutes on weekend days. The addition of mobile devices accompanied by the continuous use of traditional media may explain the differences between periods. A study carried out in the USA found that screen-time of preschool children doubled between 1997 and 2014 mainly because television time increased and was added to the use of mobile devices (Kabali et al. 2015). Still in the USA, the time spent on television, computers, and video games reportedly dropped between 2011 and 2017, but time spent on mobile phones increased significantly among children under 8 years (Rideout 2017).

The present study shows that children are still primarily engaging in screen-time through television, which is more likely to be passive compared to other media activities such as some video games now involving physical activity participation and coined “active video games” (Lanningham-Foster et al. 2009). Nevertheless, the time allocated to television was lower compared with Portuguese data from 2002 (Padez et al. 2005) which appears to be a global trend (Samdal et al. 2007; Iannotti and Wang 2013). Whether this decrease comes from lesser

use of television sets or a greater engagement in using other screens (e.g., smartphones and tablets) to watch television content, remains unknown.

In 2016/17, mobile devices were the second most common media among 3 to 6 year old children, after television, which is consistent with studies carried out among North American children aged 0 to 8 years (Rideout 2017; Chen and Adler, 2019). The literature shows a rapid development of media games, learning packages, and educational applications for young children and child target users of mobile devices are becoming younger (Strasburger and Hogan 2013). Mobile devices are expected to play an increasing role in daily life, even among young children, which has raised concerns about its impact on children's health. Previous studies have found associations between mobile screen-time and a delay in sleep onset or reduced total sleep, poorer mental health and well-being, obesity, musculoskeletal pain and ocular symptoms (Domoff et al 2019; Stiglic and Viner 2019); however, data on mobile screen-use and related health impacts are still limited.

Overall, screen-time was lower on weekdays compared with weekend days and screen-time of children aged 3-4 and 5-6-year-old was more similar during weekdays than weekend days. This may be due to the enrolment in elementary school, likely reflecting changes in the proportion of free time that is available for screen-viewing once the children start attending classes. This is in line with previous studies: a longitudinal study carried out between 1990 and 1998 found that television viewing levels off from 3 to 7 years of age (Certain and Kahn 2002); a cross-sectional study from 1999, noted that media exposure begins early, increases until children begin school, drops off briefly, then climbs again to peak at almost eight (Roberts and Foehr 2008).

In the present study, the majority of children did not meet the screen-time recommendations for age and non-adherence to the guidelines was significantly more common in 2016/17 than in 2009/10. Screen overuse seems to be a global phenomenon. In Greece, Venetsanou and colleagues (2019) registered that 63% of kindergartens were exposed to screens for more than 2 hours/day and Trinh et al. (2020) found that 87% of North American children below the age of 3 years exceed the recommended 1 hour/day. Non-adherence to screen-time recommendations was significantly higher among boys and children with low parental education level or

unemployed parents. Previous studies have found no differences according to gender among younger children (Chandra et al. 2016; Trinh et al. 2020) but prolonged screen-time in boys compared to girls in older children (LeBlanc et al. 2015). It could be explained by higher rates of video games and leisure-time computer among boys (Garcia-Contiente et al. 2013). Our findings are consistent with previous studies reporting that lower-SEP is associated with unhealthy behaviours in developed societies (Certain and Kahn 2002; Pepper and Nettle 2014; Gong et al. 2019).

Nevertheless, in past studies, association of screen-time with maternal and paternal education levels have been mixed (Lee et al. 2009; Carson and Janssen 2012; Chandra et al. 2016). The communication inequality theory states, describes the disadvantages of the lower social classes in how they access, seek, process and act on health information (Viswanath and Ackerson 2011), namely that parents of lower-SEP may tend to neglect health information from television and the Internet. Thus, they are often insensitive to the adverse impacts of prolonged screen-time and less likely to restrict their children from sedentary behaviours (Pate et al. 2011). Moreover, with the rising popularity of portable media devices and the increased affordability of these devices, socioeconomic disparities may be enhanced in the future. Consistent with previous studies, we found no association between the presence of siblings and screen-time (Hinkley et al. 2010; Duch et al. 2013).

Strengths of this study included the large, random sample of young children. Previous research has indicated that early childhood, including the transition period from preschool to elementary school is an important developmental period (Thorp et al. 2011; Jimenez et al. 2016). Second, the inclusion of mobile media devices such as tablets and smartphones in the assessment of children's screen-time, allowed us to report a more accurate current media environment. Third, this study included multiple variables as a proxy measure of SEP and, while it lacks data on household income, present findings are consistent with others using income and composite scores in developed societies, depicting the inverse relationship between higher levels of sedentary behaviours and lower-SEP (Fairclough et al. 2009; Gong et al. 2019). Lastly, the data

collected in 2009/10 and in 2016/17 allowed us to characterize the screen-time before and after commonly used mobile devices were widely available.

This study had some limitations worth noting. First, screen-time was based on parental report rather than direct observation or parental 24-hour recall diary which may jeopardize the responses due to social desirability and recall bias. Also, parents may be able to report weekend screen-time more accurately given that they are separated during school-days. Second, while the parental questionnaire was similar between the two observed periods, it might have altered the psychometric properties of the instrument, and consequently the comparability of the overall sample data is uncertain. Third, as the presented data are from two cross-sectional studies, it is not possible to study the impact of time on change in screen-viewing within participants, not is it possible to infer casual association between variables.

Research is needed to develop objective measures for screen media use (i.e., time, context and content) in children and to establish the reliability and validity of these measures. The potential harms of screen use for young children, particularly in relationship to mobile digital services, should be investigated, as should strategies for helping parents manage the screen-time of their children from early infancy onwards.

Conclusion

The present study suggest that newer media are not displacing older media but are being used in concert with them, contributing to higher screen-time in 2016/17 compared with 2009/10. Also, the rapid uptake of screens by children before 5 years of age is of particular concern because greater screen-time increases the risk of poorer developmental outcomes. Non-adherence to screen-time recommendations was more prevalent among boys and children from lower-SEP. This can help target at risk groups and provide insight into the design of prevention and intervention strategies to reduce screen-time use in young children.

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Declaration of Interest

The authors declare no conflict of interest.

Data availability statement

The data that support the findings of this study are available from the corresponding author, DR, or from the co-author and Projects' Principal Investigator, CP.

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Table 1. Descriptive statistics for demographic variables, n (%), data collected in 2009/10 (n=3080) and 2016/17 (n=3797), mainland Portugal.

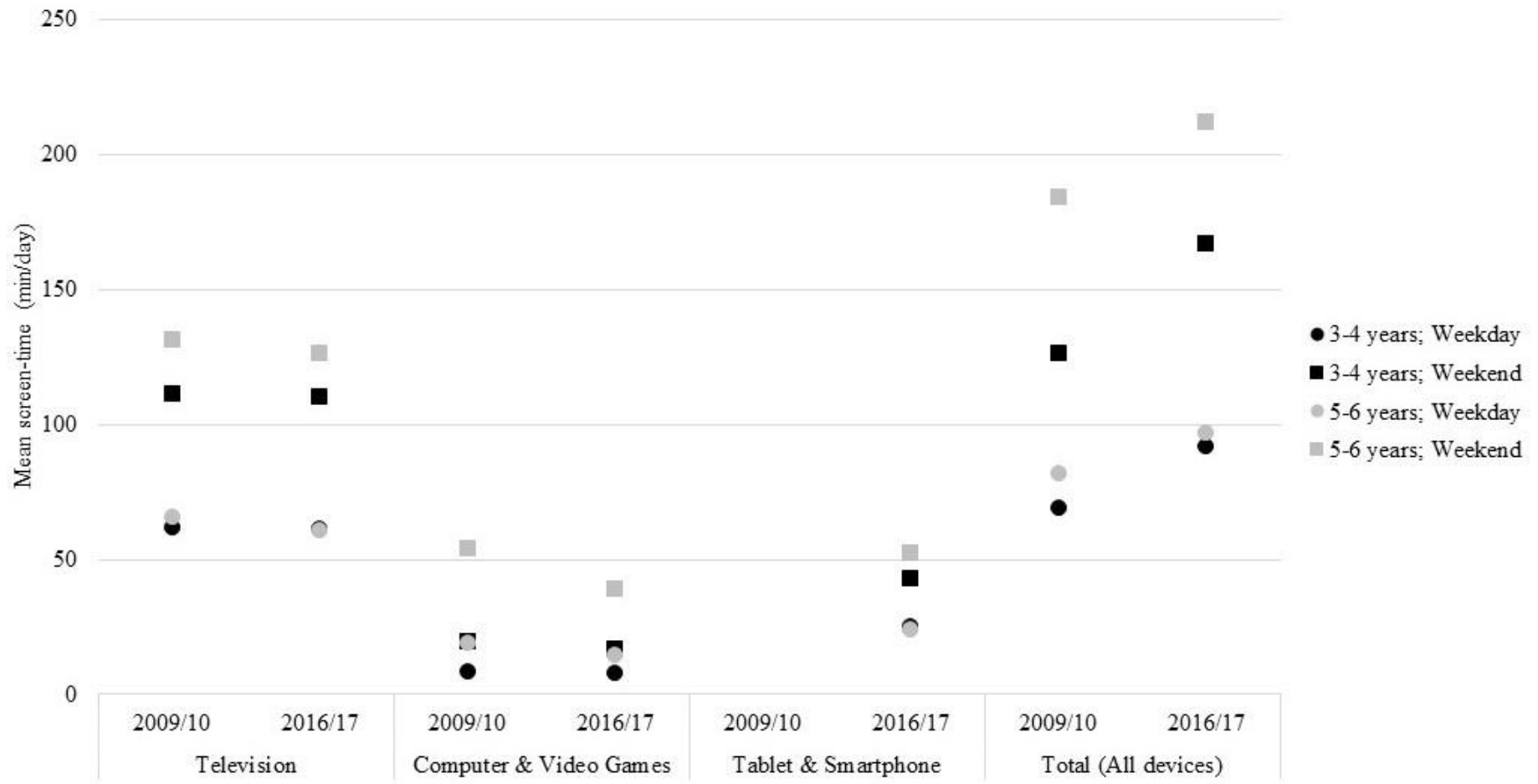
	2009/10			2016/17		
	3-4 years	5-6 years	Total	3-4 years	5-6 years	Total
CHILD Gender						
Boys	666(48.5)	831(48.7)	1497(48.6)	704(53.0)	1230(49.8)	1934(50.9)
Girls	706(51.5)	877(51.3)	1583(51.4)	624(47.0)	1239(50.2)	1863(49.1)
CHILD Siblings						
Only child	498(38.3)	549(33.4)	1047(35.6)	405(33.9)	668(29.3)	1073(30.9)
1 sibling	598(46.0)	784(47.7)	1382(47.0)	597(50.0)	1139(50.0)	1736(50.0)
≥2 siblings	204(15.7)	310(18.9)	514(17.5)	191(16.0)	470(20.6)	661(19.0)
FATHER Education						
≤9 years	463(36.3)	601(38.6)	1066(37.5)	260(22.4)	491(22.7)	751(22.5)
10-12 years	396(30.9)	441(28.3)	837(29.5)	462(39.8)	788(36.4)	1253(37.6)
University	421(32.8)	515(33.1)	936(33.0)	439(37.8)	884(40.9)	1328(39.9)
FATHER Occupation						
Working	1166(92.4)	1396(91.3)	229(8.2)	1082(93.5)	1986(92.9)	228(6.9)
Unemployed	96(7.6)	133(8.7)	2562(91.8)	75(6.5)	152(7.1)	3075(93.1)
MOTHER Education						
≤9 years	385(29.0)	487(29.8)	872(29.4)	153(12.8)	315(14.0)	468(13.6)
10-12 years	386(29.0)	541(33.1)	927(31.3)	443(37.1)	793(35.1)	1236(35.8)
University	558(40.7)	606(37.1)	1164(39.3)	598(50.1)	1149(50.9)	1747(50.6)
MOTHER Occupation						
Working	1101(85.2)	1391(86.7)	406(14.0)	996(84.7)	1880(84.8)	519(15.3)
Unemployed	192(14.8)	214(13.3)	2492(86.0)	180(15.3)	336(15.2)	2881(84.7)

Table 2. Associations of children's and family characteristics with excess screen time on weekdays and weekend days (95% confidence interval) in 2009/10 (n=3080) and 2016/17 (n=3797).

	3 – 4 years †				5 - 6 years ‡			
	2009/10		2016/17		2009/10		2016/17	
	Week	Weekend	Week	Weekend	Week	Weekend	Week	Weekend
Gender								
Boys	1.22 (1.04-1.44)	1.03 (0.85-1.25)	1.02 (0.77-1.36)	1.59 (0.98-2.59)	1.43 (1.23-1.67)	1.39 (1.18-1.65)	1.37 (1.12-1.68)	1.14 (0.89-1.45)
Girls	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Siblings								
Only child	1.41 (1.08-1.84)	1.03 (0.75-1.43)	1.22 (0.78-1.92)	1.20 (0.57-2.53)	1.06 (0.83-1.35)	0.94 (0.72-1.22)	1.10 (0.81-1.48)	0.79 (0.55-1.15)
1 sibling	1.18 (0.91-1.52)	0.94 (0.69-1.28)	0.95 (0.63-1.45)	1.19 (0.60-2.37)	1.12 (0.89-1.40)	1.05 (0.82-1.34)	0.87 (0.67-1.15)	0.88 (0.63-1.23)
≥2 siblings	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Father education								
Low	0.89 (0.70-1.14)	0.88 (0.66-1.19)	1.34 (0.83-2.16)	1.70 (0.78-3.73)	1.01 (0.79-1.28)	1.20 (0.93-1.54)	1.47 (1.05-2.05)	1.09 (0.73-1.63)
Middle	0.95 (0.76-1.18)	1.12 (0.85-1.48)	1.18 (0.84-1.65)	2.53 (1.32-4.86)	1.08 (0.86-1.34)	1.46 (1.15-1.85)	1.47 (1.14-1.89)	1.35 (1.00-1.81)
High	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Father working								

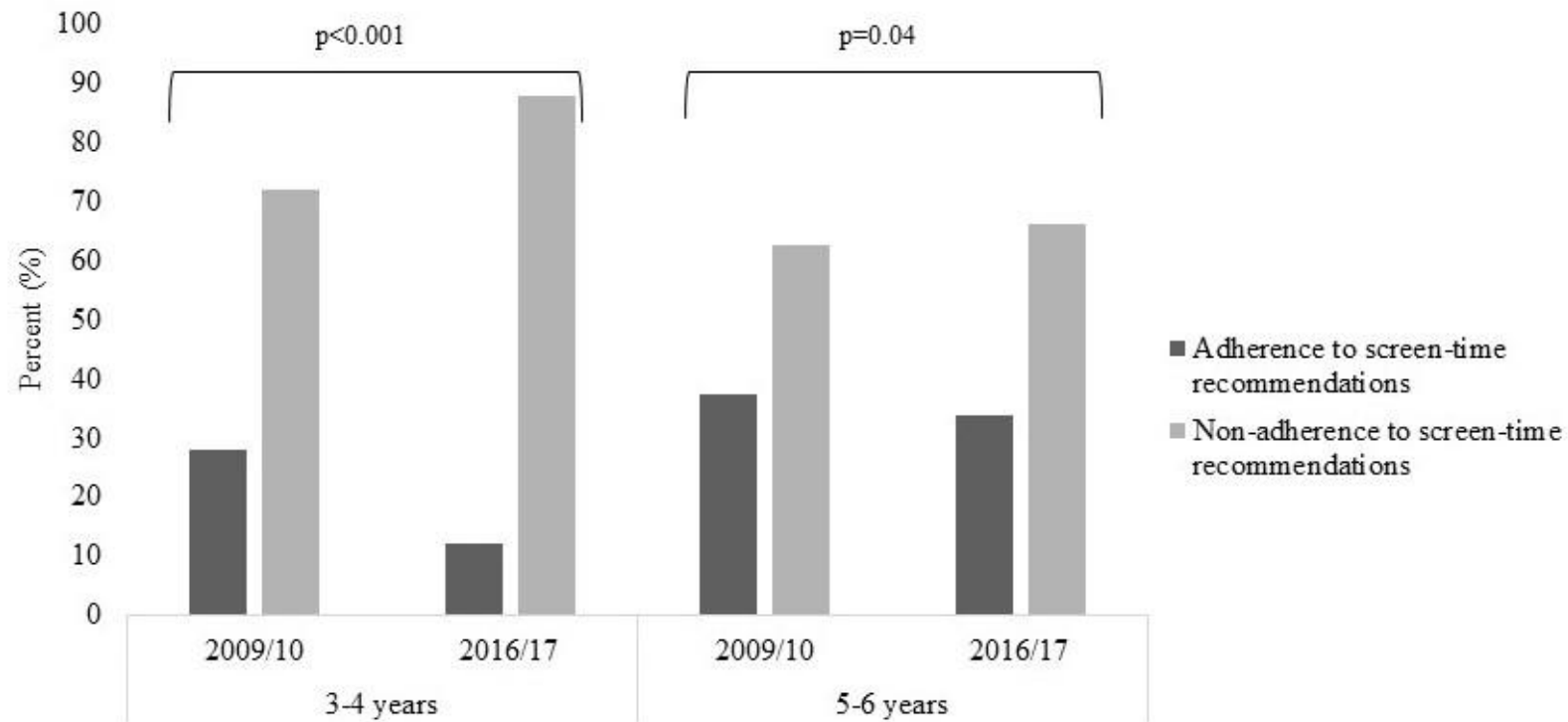
No	1.47 (1.03-2.11)	0.92 (0.60-1.41)	1.27 (0.65-2.49)	0.52 (0.22-1.25)	1.50 (1.10-2.03)	1.52 (1.03-2.23)	1.24 (0.82-1.88)	1.58 (0.85-2.97)
Yes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Mother education								
Low	1.18 (0.92-1.53)	0.99 (0.72-1.35)	1.31 (0.71-2.45)	0.40 (0.15-1.04)	1.68 (1.31-2.15)	0.97 (0.74-1.27)	1.66 (1.13-2.43)	1.29 (0.78-2.13)
Middle	1.15 (0.93-1.42)	1.17 (0.90-1.52)	1.03 (0.73-1.45)	0.51 (0.28-0.96)	1.30 (1.06-1.60)	1.03 (0.82-1.28)	1.20 (0.93-1.54)	1.28 (0.94-1.74)
High	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Mother working								
No	1.47 (1.14-1.89)	0.98 (0.73-1.32)	1.30 (0.84-2.02)	1.44 (0.68-3.04)	1.57 (1.26-1.95)	0.94 (0.74-1.21)	1.55 (1.16-2.05)	1.29 (0.87-1.91)
Yes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Note. Recommendations for screen time: † less than 60min/day; ‡ less than 120min/day. Father and mother working: no refers to unemployed parents (does not include retired). Models are mutually adjusted for all variables.



1

2 Figure 1. Mean daily screen-time in 2009/10 and 2016/17 for Portuguese children aged 3 to 6 years.



3

4 Figure 2. Proportions of Portuguese children (aged 3 to 6 years) whose total screen-time was within or exceeded the recommended maximum for age.