BMJ Open

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Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2015-009113
Article Type:	Research
Date Submitted by the Author:	17-Jun-2015
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Primary Subject Heading:	Public health
Secondary Subject Heading:	Paediatrics, Epidemiology
Keywords:	screen viewing, screen devices, infants, toddlers, prevalence, determinants

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Sociodemographic, home environment, and parental influences on total and device-specific screen viewing in children aged 2 years and below – an observational study

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ABSTRACT

Objective

This study aimed to investigate total and device-specific screen viewing (SV) and its determinants in children aged two years and below.

Design

Cross-sectional study conducted in February 2014

Setting

Well-child clinics in Singapore national polyclinics.

Participants

Parents of children (Singapore citizens or permanent residents) aged two years and below were enrolled during routine clinic visits. Out of 794 eligible parent-child dyads, 725 (91.3%) provided informed consent and were included in the analysis.

Main outcome measures

Device-specific information on SV and determinants were ascertained using interviewer-administered survey questionnaires. Prevalence and duration of aggregate and device specific SV was reported. Associations with potential determinants were investigated using multiple logistic regression analysis. A p-value less than 0.05 was considered statistically significant.

Results

The prevalence of daily SV and SV ≥ 2 hours per day constituted 53.5% and 16.3%, respectively. The majority of children aged 18-24 months (88.2%) engaged in daily SV. TVs and mobile devices were the most commonly used screen devices, followed by computers and video consoles. In multivariable analysis, younger child age, Chinese ethnicity and setting rules on time of SV were strongly and consistently associated with lower levels of any SV and SV ≥ 2 hours per day. Parental knowledge of SV recommendations and less parental SV were additionally associated with lower levels of SV ≥ 2 hours per day. The number of screen devices was not associated with children's SV.

Conclusion

In contrast to recommendations, SV increases steadily throughout the first two years of a child's life with TVs and mobile devices being most frequently used. Improving parental knowledge of SV recommendations, reducing parental SV and especially the implementation of strict rules on SV time could be successful strategies to reduce SV in young children.

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Article summary

Strengths and limitations of this study

Strengths

- This study investigates screen viewing in very young children not only considering television viewing but also other relevant up to date screen device types, such as computers, game consoles and mobile devices
- The study comprehensively assesses socio-demographic, parental and home environmental influences on screen viewing
- Our findings are based on a large multi-ethnic Asian population with very high response rate
- The study provides evidence that is highly applicable to the development of early childhood interventions aimed to reduce screen viewing

Limitations

- The main limitation is the fact that screen viewing as the main outcome was not determined objectively

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Background

Screen viewing (SV) has been associated with substantial detrimental health effects, including a higher risk of type 2 diabetes mellitus, cardiovascular diseases and premature mortality [1 2]. In children, increases in the time spent on SV has been found to negatively affect cognitive and language development [3 4], social interaction [5 6], attention deficits [4 7 8], as well as behavioral problems [9-11]. SV in children has also been linked to obesity [12], metabolic risk , and impaired vision [13-15].

For children above the age of 2 years, SV recommendations usually state not to engage in more than 2 hours of television (TV) or screen time per day [16]. However, recent evidence-based recommendations for very young children (here defined as children below the age of 2 years) have discouraged SV altogether [17 18]. Despite of these recommendations, the use of screen devices in young children seems to have become common practice in recent years. For instance, in Japan, 86% of children spend over 1 hour of TV time a day by 18 months of age [19]. In Australia, the average child between 0 and 4 years spends 2.5 hours on TV [20] per day. Similarly, in the United States, 90% of children regularly watch TV or videos by age two, with average duration exceeding 1.5 hours a day [21 22].

Such sedentary behaviors have been shown to persist across age, indicating that children who spent more time watching TV, watch more TV later in life and that these early life behaviors could be associated with adverse health consequences, such as, increased body-mass index and serum cholesterol levels, as well as decreased cardio-respiratory fitness later in life [23-26]. The increasing amount of time children spent on SV and the potential long-term implications of SV highlight the public health importance of preventing the adoption of SV behaviors early in life.

With technological advancements, screen devices have become pervasive in everyday life. Nowadays, comprehensive assessments of SV patterns in children have to consider not only TV, computer and video consoles, but also mobile screen devices, especially smart phones and tablets [16]. Their portability and ease of use anywhere and anytime could have important implications on the way these screen devices are being used. Studies in older children and adolescents have already highlighted their widespread use [27 28]. However, little is known about current SV patterns in young children, especially with regard to the use of different screen devices [29 30], despite the common perception that modern mobile screen devices

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are more interactive and possibly beneficial for children's health. According to a recent systematic review of the available evidence in children aged three years and below, the majority of studies reported TV and video viewing. Only five studies have reported computer use and no studies have explored mobile device use [31]. Equally important, little is known about the time when children begin to be exposed to these devices on a regular basis, their socio-demographic profile and potentially modifiable determinants. This knowledge is important to understand when and how best to prevent excessive SV behavior in children but also later in life.

This study aimed to investigate overall and device-specific SV patterns in children aged two years and below. It also investigate changes in SV behavior across age, socio-demographic factors, screen home environment, as well as parental knowledge and practice related determinants of early childhood SV.

METHODOLOGY

Participants and procedures

This was a cross-sectional study conducted in February 2014 among parents bringing their healthy children, aged two years and below, to two National Healthcare Group Polyclinics (Singapore has a total of 18 polyclinics) for their well child health visits, which may include developmental assessment and/or vaccinations. The take up rate of this Program for children up to two years is more than 97%, providing a good representation of the children in the region at a given point in time [32]. Parents satisfying the eligibility criteria were invited to participate in the study. Participants who were not Singapore citizens were excluded and verbal consent from the participants was obtained. After consent was obtained, trained interviewers administered survey questionnaires in a standardized form in the participants' preferred language (English, Chinese, Malay, and Tamil) during clinic visits.

This study was approved by the Singapore National Health Care Group Domain Speific Review Boards (DSRBs). Participation was entirely voluntary and informed consent was received from all the parents or caregivers.

Measurements

The study questionnaire was developed following comprehensive literature review and refined through pilot studies. Interviewers were trained to ensure consistent administration of the survey questionnaires.

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Screen viewing (SV) behavior

Parents were asked to provide information about the amount of screen time their child was exposed to during weekdays and weekends. Parental recall of their child's SV time has been shown to be reliable, correlating well within previous observational studies [33]. SV behavior was ascertained in four broad device categories: TV/Digital Video Disc (DVD), computer, video game consoles and mobile devices (including smart phones, tablets and other portable devices). To determine total SV, the amount of time spent on individual device categories was added up for weekdays and weekends with weights corresponding to 5/7 and 2/7, respectively. Subsequently total SV time during the entire week was calculated. Each device specific SV time was determined in the same way but only including information for respective devices.

Two SV statuses are presented as "any SV per day" and "SV ≥ 2 hours per day" on any device, as well as for different screen devices.

Independent variables

Socio-demographic information of the parent was recorded, including ethnicity, parents' education, parental marital status, and household income, together with the child's age and gender. The screen environment at home was determined by assessing the number of functioning screen devices at home. The number of screen devices was recorded separately for each device type. Parental knowledge of professional SV recommendations for children under the age of two years was categorized into three categories: minimize SV altogether, less than 2 hours of SV time, and ≥ 2 hours of SV time. Parental SV was determined and summarized in the same way as for children. Total parental SV time was categorized according to tertiles.

Parental rule setting practices focused on whether parents set rules on the time (duration per day) and the program (content) of their child's SV, respectively. These variables were combined (parents that set rules on both time and type of program versus parents who did not set rules on time and program) because of the strong association between both variables. The exact daily SV time permitted according to

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parental rules was further assessed and categorized into four groups: "no SV rules", "SV time ≥ 2 hours" rule, "SV time of less than 2 hours" rule, and "no SV time" rule.

Data analysis

For categorical variables, counts and percentages were reported while for continuous variable, the median and interquartile ranges (IQR) were reported. To assess association between categorical variables, the Chi-square or Fisher exact tests were used where appropriate. The Kruskal-wallis test was used to assess association between continuous and categorical variables. Multiple logistic regression was used to model two representations of SV status, "any SV per day" and "SV of ≥ 2 hours per day" (representing "heavy users"), where socio-demographic factors, parental knowledge and practices were the independent variables. In these analyses, both rule setting characteristics (time and program) were combined as "parents that set rules on time and type of program". To further explore the association with specific types of rules and the strictness of rules on time (with regard to the permitted duration of SV per day), multiple logistic regression analysis was performed separately for "rules on time", "rules on program", and the strictness of rules on time in terms of the permitted SV time. The odds ratio (OR), its 95% confidence interval (95%CI) and p-values were reported. A p-value <0.05 was considered statistically significant. The statistical analysis was carried out using IBM Statistical Package for Social Sciences and Stata 12.

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RESULTS

Study population

All 1061 parent-child dyads visiting the assessment sites during the assessment periods were approached. Of them, 794 met the inclusion criteria and 725 (91.3%) provided consent, participated in the survey and provided complete information on the outcome variables of SV time.

Child and parental characteristics of the study population are presented in Table 1. Findings show that 55.3% of children were male and the majority (58.6%) were of Chinese ethnicity with the remainder being mostly of Malay or Indian ethnicity. The median age of the children was 7 (IQR: 10) months with 44.7% being younger than 6 months and 55.3% being 6-24 months old. Majority of the parents were married (98.1%) where 79.5% of fathers and 76.0% of mothers had attained an educational level of post-secondary school and above. The majority of the households (81.1%) had a monthly income of 3000 SGD (where 3000 SGD is approximately 2011 USD) or more.

The most common screen devices in households were mobile devices with a median of 4 devices per household, followed by TVs and computer. Video game consoles were considerably less common. With regard to the knowledge about professional SV recommendations, only 12.7% of parents were aware that SV in children below the age of two should be minimized and almost twice as many parents (26%) believed that the recommended duration was 2 hours or more per day is recommended by guidelines. About 80% of parents set rules on time or program of SV, and about 75% set rules on both time and program. Although more than 10% of parents appear knowledgeable of professional SV recommendations, less than 5% among parents with rules on SV time had rules that aimed to minimize SV. Similarly, more than 75% of parents with rules on SV time set rules of less than 2 hours SV per day (or 63% among all 725 parents).

Screen viewing behavior

The prevalence of daily SV among children is presented in detail in Table 2. Overall prevalence of daily SV was 53.5%, with TVs being most widely used (44.8%), followed by mobile devices (30.5%), computers (6.6%) and video game consoles (0.4%). The prevalence of daily SV of 2 hours or more per day across all devices

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was 16.3%, and the prevalence for TV, mobile device, computer and video game console viewing were 11.4%, 3.9%, 1.0% and 0.0% respectively.

Figure 1 presents the prevalence of daily total SV and by device, as well as SV 2 hours or more per day across 6 month age groups. Among children younger than 6 months, any daily SV activity was reported in 29%, and the prevalence increased steeply across age groups to 88.2% at age 18-24 months. Differences between age groups and SV status across all devices and each device (apart from video consoles) were statistically significant. In all age groups, TV viewing was the most common form of SV behavior, followed by mobile devices, computers and video game consoles. The difference in prevalence of SV between TV and mobile device was less pronounced at age 18-24 months as compared with the younger age groups.

In those with any SV activity (Table 3) median total SV was 60.0 (IQR: 95.7) minutes per day among children aged less than 6 months. It increased to 80 (IQR: 120) minutes per day in those aged 18 to 24 months (p=0.0004). SV aggregated across devices increased with age (p=0.0004), but when investigating different devices a statistically significant increase was only observed for mobile devices.

Socio-demographic, screen home environmental, parental knowledge and practice correlates of SV in children

In unadjusted analysis, increased child age, Malay and Indian ethnicity and lower maternal educational level were significantly associated with higher prevalence of any daily SV behaviour among the socio-demographic variables (Table 4). The screen home environment was not significantly associated with screen viewing behaviour and a borderline significant association between inaccurate parental knowledge of professional SV recommendations and higher prevalence of any daily SV behavior was found. With regard to practices, parental SV was not significantly associated with daily SV behaviour but the absence of rule setting practices were significantly associated with higher prevalence of any SV activity among children.

When controlling for all other variables, older children (OR: 8.07, 95% CI: 5.57 to 11.69), and children with Malay (OR: 2.72, 95% CI: 1.73 to 4.28), Indian (OR: 2.53, 95% CI: 1.39 to 4.61), other ethnicities (OR: 3.19, 95% CI: 1.13 to 9.05) had a

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significantly increased odds of daily SV. Among home environmental variables, parents who reported having two TV's were significantly more likely to report screen viewing in their children (OR: 1.57, 95% CI: 1.03 to 2.40). Although the association between knowledge of SV recommendations and children engaging in any SV was insignificant, parents who believed that guidelines recommend more than 2 hours of SV had a significant greater odds of engaging in any SV (OR: 1.84, 95% CI: 1.00 to 3.39). Similarly, children of parents who specified screen time rules had a significant reduced odds of any SV activity (OR: 0.65, 95% CI: 0.43 to 0.98).

As presented in Table 5, observed associations with regards to 2 or more hours of SV per day were similar for socio-demographic variables. However, associations with parental knowledge, parental SV and parental rule setting were more consistently and more strongly associated with viewing two or more hours per day as compared to any daily SV. The screen home environment had devices with significant associations in the unadjusted analysis. Specifically, greater number of TVs, mobile devices and video game console were significantly associated with higher prevalence of SV time 2 or more hours. However, they become insignificant in the adjusted analysis. Different from Table 4, incorrect parental belief on SV recommendations and higher parental SV time were significantly associated with higher prevalence of SV time 2 or more hours. Moreover, rule setting practices were significantly associated with lower SV. These significant findings persisted after adjustment.

Association of rule setting type and strictness with SV

Table 6 presents unadjusted and adjusted associations of rule setting practices with any SV and SV of ≥ 2 hours per day. Regardless of the SV outcome and adjustment "rules on program" were not significantly associated with SV in young children. On the contrary, "rules on time" were consistently associated with a lower likelihood of any SV and SV of ≥ 2 hours per day. Moreover, stricter rules on SV time were consistently associated with lower levels of any SV and SV of ≥ 2 hours per day.

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DISCUSSION

This study investigated SV patterns and their correlates in very young children, considering multiple different screen device types, including TV, computer, but also mobile screen devices and video game consoles. Given the widespread use, especially of mobile screen devices in day to day life, this comprehensive approach is important to fully understand SV patterns. Based on a recent systematic review of the literature, this study is the first in young children to investigate SV patterns and their correlates in such detail [31].

Our findings show that among children up to the age of two SV on a daily basis is highly common. Even in children aged less than 6 month, about 30 percent were engaging daily in SV. This was followed by a steep increase in older age groups and by the age of 18-24 months, about 90% of children engaged in daily SV activities. We also observed an increase in SV time with increasing age, so that by the age of 18-24 months the median SV time was almost 1.5 hours per day and almost 1/3 of the children were engaging in 2 or more hours of SV time per day. Our findings are consistent with research from other countries that have previously reported high exposure to TV, computer and videos at young ages [22].

Although TVs still appear to be the most common form of screen devices young children are exposed to, our findings also highlight that TVs are not the only relevant screen device children are using. Mobile devices have become widely available in the entire population and they now seem to reflect the second most important source of SV in very young children. Furthermore, we noted that the difference in the prevalence between TV and mobile devices is least pronounced at the age of 18 to 24 months when compared with younger age groups making SV attributable to mobile devices comparable with TVs. Moreover, in terms of the SV time, we noted a significant difference across age groups for total SV and mobile devices but not for TVs or other screen devices. Previous studies from the US and Europe, targeting older children, have also reported on the frequent use of mobile devices. In addition, recent discussions in the scientific literature have addressed the potential health implications of the widespread use of modern mobile screen devices in very young children, but our study appears to be among the first to comprehensively quantify patterns and relevant correlates in this population [27 29 30].

Besides age, we noted that Malay, Indian and other ethnic groups were considerably more likely to engage in any SV and two or more hours of SV per day as compared

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to Chinese. This is consistent with existing literature that also reported ethnic differences in SV in Western populations [31 34]. On the other hand, we did not identify significant associations between daily SV or SV of two or more hours per day and other socio-demographic variables, such as child's gender, mother's or father's educational level, income, and parental marital status when taking potential confounders into consideration [31].

Parental knowledge and parenting practices may have the potential to reflect targets for health promotion strategies to reduce or delay the update of SV in very young children. Our study found strong and consistent associations between child SV and parental rule setting practices. Findings indicate that children are less likely to engage in SV if parents set rules on SV time, and additionally if the rules on SV time are stricter. On the other hand, rules on programs did not appear to be significantly associated with SV in children. A recent systematic review of the literature reported mixed and less consistent findings of such TV policies at home. However, this review summarized studies of very different methodology and importantly mostly targeting older children and adolescents. Only two of the included studies had focused on children below the age of two, and they only concentrated on TV viewing [35-37]. Our findings are similar to previous research in older children, however, that also indicated that the type of rules (time or program) may have implications in terms of SV [37]. In addition to rule setting practices, knowledge of professional screen viewing recommendations and parental screen viewing behaviour were significantly associated with screen viewing in children, particularly with viewing 2 or more hours per day. These findings seem to be consistent with studies conducted in older children and adolescents that reported associations between children's and parental screen viewing [27 31 38].

Our study has a number of strength, including a very high participation rate and detailed outcome assessments. Building on Singapore's National Childhood Immunization program facilitated this study of a defined population of healthy children aged two and below. Some limitations have to be acknowledged, though. First, the survey recruited from two out of the eighteen polyclinics covering the whole of Singapore. Variations in the overall population reflected in the other centers may hence be unaccounted for. Second, this is a cross-sectional study which limits its ability to draw inferences about the direction of cause and effect. However, modern screen devices, in particular tablets, have only become widely used after the launch

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of the Ipad in 2010. Hence, at this stage longitudinal data on the use and determinants of modern screen devices is not available. Third, the study was conducted in February and may not reflect seasonal variations in screen time exposure, although seasonal variation in weather is limited in tropical Singapore. Fourth, our study relied on self-report information and could not use objectively determined exposure and outcome measures, which could introduce measurement bias. Finally, we did not distinguish between the type of program screen time was spent on or whether it was for instance spend for video calling with family members. This will be important to consider in future studies because research has indicated that health consequences may vary depending on the activity performed [39].

Our findings have considerable public health implications because they highlight the importance of targeting SV practices at a very early age, ideally even during the first six months of life in order to develop appropriate practices to prevent the update of these activities in the first place. Our study also showed that TV viewing still seems to be the most common but not the only relevant screen device young children are exposed to. With increasing age, mobile devices take up an increasing part of total screen viewing time and by the age of 18 to 24 months almost as prevalent as TVs. Different devices may require different intervention strategies and recommendations, given their portability, small size and multifunctional usability (eg. watching videos, playing games, reading, listening to audio books). We were able to identify a number of potentially modifiable factors that were strongly associated with SV practices in children, including parental knowledge of professional SV recommendations, parental SV and rule setting practices, and to a lesser degree the number of devices in the household, These findings were particularly present in the case of heavy SV, which suggests that reducing SV behavior in young children might be an achievable target, while replacing SV entirely could be more challenging. Modifiable factors offer opportunities for health promotion strategies, administered for instance by health care professionals during developmental assessments or teachers in child care centers at a very young age. This could help to delay and reduce screen viewing in children. Our findings are consistent with earlier publications that reported a high prevalence of regular TV viewing in very young children [19 20 22 40]. However, our findings expand the existing literature considerably in various aspects. Importantly, we were able to investigate multiple up to date screen device types and a broad spectrum of socio-demographic, environmental, parental knowledge and practices

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related correlates of screen viewing in very young children. In addition, literature reviews have shown that the bulk of the existing evidence comes from the US and Europe, with a very limited number of studies from Asian countries, despite the rapid economic development and increasing concerns about the increase in non-communicable diseases [31].

In conclusion, our study found a steady increase in the prevalence of daily SV within the first two years of a child. By the age of two years almost all children were exposed to screen devices daily and a substantial proportion of this young study population exceeded two hours of SV, usually recommended as the maximum for much older children. While TV viewing remains the most common contributor to overall SV in children, our findings also confirm the increasingly important role of mobile screen devices. Strategies aimed to reduce the rapid uptake of regular SV practices in children are urgently needed to influence future behaviours and health. We were able to identify potential targets for such strategies, especially for SV or 2 or more hours per day, including parental knowledge regarding professional SV recommendations, parental SV practices and the implementation of strict rules on SV time in young children.

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Figure legend

Figure 1 Prevalence of screen viewing behaviour overall and according to device type according to 6 month age groups (n=725). *Difference across age groups, p<0.001.

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Table 1 Participant, child and household characteristics (n=725)

	N per group	% of total
Socio-demographic characteristics		
Male	401	55.3
Female	324	44.7
< 6 month	324	44.7
6-24 month	401	55.3
Age in months (median, IQR)	725	7.0 (10.0)
Chinese	425	58.6
Malay	196	27.0
Indian	82	11.3
Other	22	3.0
Parents not married	14	1.9
Parents married	711	98.1
Mother education (primary/secondary)	174	24.0
Mother education (postsecondary and above)	551	76.0
Father education (primary/secondary)	148	20.5
Father education (postsecondary and above)	575	79.5
Income, <3000 SGD	134	18.9
Income, 3000 to 6000 SGD	297	41.8
Income, 6001 to 9000 SGD	170	23.9
Income, >9000 SGD	109	15.4
Screen home environment		
Number of TVs, (median, IQR)	725	2 (1)
Number of mobile devices, (median, IQR)	725	4 (2)
Number of Computers, (median, IQR)	725	2 (1)
Number of Video Consoles, (median, IQR)	725	0 (1)
Parental knowledge of professional screen viewing recommendations		
recommend minimal viewing	91	12.7

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recommend viewing < 2 hours/day	439	61.3
recommend viewing ≥ 2 hours/day	186	26.0
Parental screen viewing practices		
Parent screen time, hours/day (median, IQR)	713	8.0 (7.7)
Parental rule setting practices		
Rules on time	594	82.9
Rules on program content	583	81.4
Rules on time and program	539	75.2
Rules on time*, no screen time	27	4.6
Rules on time,* less than 2 hours	457	76.9
Rules on time*, ≥ 2 hours	110	18.5

*Based on participants who set rules on screen viewing time (n=594)

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Table 2 Total and device-specific screen viewing (n=725)

	no screen viewing		up to 2 hours of screen viewing		≥ 2 hours of screen viewing	
	N	%	N	%	N	%
Total screen time	337	46.5	270	37.2	118	16.3
TV	400	55.2	242	33.4	83	11.4
Mobile device	504	69.5	193	26.6	28	3.9
Computer	677	93.4	41	5.7	7	1.0
Video game console	722	99.6	3	0.4	0	0.0

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Table 3 Screen viewing according to age groups and median screen viewing time among children who are exposed to screen devices

	<6 months (n=324)				6 to <12 (n=164)				12 to <18 (n=144)				18 to 24 month (n=93)				
	N	%	Median	IQR	N	%	Median	IQR	N	%	Median	IQR	N	%	Median	IQR	p-value*
Total screen time	94	29.0	60.0	95.7	102	62.2	60.0	90.0	110	76.4	70.0	122.1	82	88.2	80.0	120.0	0.0004
TV	79	24.4	45.0	81.4	84	51.2	51.4	97.1	95	66.0	60.0	98.6	67	72.0	60.0	72.9	0.5820
Mobile device	42	13.0	23.2	49.3	46	28.0	23.6	22.1	72	50.0	32.1	45.0	61	65.6	40.0	30.0	0.0004
Computer	7	2.2	21.4	32.9	14	8.5	30.0	32.9	11	7.6	30.0	45.0	16	17.2	43.9	75.0	0.0876
Video consoles	1	0.3	5.7	0.0	0	0.0	-	-	1	0.7	60.0	0.0	1	1.1	10.0	0.0	0.3679

*for comparison of median screen viewing across age groups

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Table 4 Unadjusted and adjusted associations between any SV activity and socio-demographic, home-environment, parental knowledge and practices

	N	% screen viewing	Unadjusted Model				Multivariable Model*			
			OR	Lower 95% CI	Upper 95% CI	p-value	OR*	Lower 95% CI	Upper 95% CI	p-value*
Sociodemographic characteristics										
Age, < 6 month	324	29.0	1.0				1.0			
Age, > 6 month	401	73.3	6.72	4.85	9.32	<0.001	8.07	5.57	11.69	<0.001
Chinese	425	46.6	1.0			<0.001[#]	1.0			<0.001[#]
Malay	196	65.3	2.16	1.52	3.06	<0.001	2.72	1.73	4.28	<0.001
Indian	82	58.5	1.62	1.00	2.61	0.049	2.53	1.39	4.61	0.002
Others	22	63.6	2.01	0.82	4.88	0.125	3.19	1.13	9.05	0.029
Male	401	55.1	1.0				1.0			
Female	324	51.5	0.87	0.65	1.16	0.338	0.93	0.65	1.32	0.686
Mother education (primary/secondary)	174	60.9	1.0				1.0			
Mother education (postsecondary)	551	51.2	0.67	0.48	0.95	0.025	0.70	0.42	1.16	0.167
father education (primary/secondary)	148	59.5	1.0				1.0			
Father education (postsecondary)	575	51.8	0.73	0.51	1.06	0.098	1.00	0.60	1.66	0.993
Income, <3000	134	58.2	1.0			0.278[#]	1.0			0.929[#]
Income, 3000 to 6000	297	54.2	0.85	0.56	1.28	0.439	0.96	0.57	1.62	0.882

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Income, 6001 to 9000	170	52.4	0.79	0.50	1.25	0.309	1.11	0.59	2.08	0.755
Income, >9000	109	45.9	0.61	0.37	1.01	0.056	0.94	0.47	1.90	0.866
Parents married	711	53.3	1.0				1.0			
Parents not married	14	64.3	1.58	0.52	4.75	0.418	1.85	0.52	6.62	0.343
Screen home environment										
up to 1 TV	309	49.5	1.0			0.176#	1.0			0.111#
2 TVs	236	56.8	1.34	0.95	1.88	0.093	1.57	1.03	2.40	0.036
3+ TVs	180	56.1	1.30	0.90	1.89	0.159	1.29	0.79	2.10	0.315
up to 2 mobile devices	157	47.8	1.0			0.265#	1.0			0.326#
3 mobile devices	199	55.3	1.35	0.89	2.06	0.160	1.47	0.89	2.45	0.135
4 + mobile devices	369	55.0	1.34	0.92	1.94	0.128	1.26	0.77	2.07	0.352
up to 1 computer	312	58.3	1.0			0.078#	1.0			0.892#
2 Computers	242	49.8	0.71	0.51	0.99	0.046	1.10	0.72	1.70	0.656
3+ Computers	171	50.0	0.71	0.49	1.04	0.078	1.02	0.61	1.70	0.939
0 Video consoles	504	53.0	1.0				1.0			
1+ Video consoles	221	54.8	1.07	0.78	1.48	0.659	1.04	0.69	1.56	0.863
Parental knowledge of professional recommendations										
recommend minimal viewing	91	41.8	1.0			0.058#	1.0			0.145#
recommend viewing < 2 hours/day	439	55.1	1.71	1.08	2.71	0.021	1.45	0.85	2.46	0.172

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	N	%	OR	CI	CI	p	OR*	CI	CI	p
recommend viewing > 2 hours/day	186	55.4	1.73	1.04	2.87	0.034	1.84	1.00	3.39	0.049
Parental screen viewing practices										
Parent screen time (lowest tertile)	238	55.9	1.0			0.357[#]	1.0			0.430[#]
Parent screen (medium tertile)	240	55.0	0.96	0.67	1.38	0.846	0.88	0.57	1.36	0.568
Parent screen time (highest tertile)	235	49.8	0.78	0.55	1.12	0.185	0.75	0.48	1.16	0.196
Parental rule setting practices										
No rules on time and programme	178	60.7	1.0				1.0			
Rules on time and program	539	51.2	0.68	0.48	0.96	0.029	0.65	0.43	0.98	0.041

* adjusted for all other co-variables, [#] overall p-value

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Table 5 Unadjusted and adjusted associations between SV time per day ≥ 2 hours and socio-demographic, home-environment, parental knowledge and practices

	N	% screen viewing	Unadjusted Model				Multivariable Model*			
			OR	Lower 95% CI	Upper 95% CI	p-value	OR	Lower 95% CI	Upper 95% CI	p-value
Sociodemographic characteristics										
Age, < 6 month	324	7.7	1.0				1.0			
Age, > 6 month	401	23.2	3.61	2.26	5.77	<0.001	4.88	2.87	8.31	<0.001
Chinese	425	9.7	1.0			<0.001[#]	1.0			<0.001[#]
Malay	196	28.1	3.65	2.33	5.72	<0.001	3.93	2.26	6.85	<0.001
Indian	82	19.5	2.27	1.20	4.28	0.011	4.14	1.88	9.12	<0.001
Others	22	27.3	3.51	1.30	9.47	0.013	5.39	1.70	17.08	0.004
Male	401	17.5	1.0				1.0			
Female	324	14.8	0.82	0.55	1.23	0.339	0.80	0.50	1.28	0.353
mother education (primary/secondary)	174	21.8	1.0				1.0			
mother education (postsecondary)	551	14.5	0.61	0.40	0.94	0.024	0.68	0.37	1.27	0.227
father education (primary/secondary)	148	21.0	1.0				1.0			
Father education (postsecondary)	575	15.1	0.67	0.43	1.06	0.089	0.90	0.49	1.66	0.737
Income, <3000	134	19.4	1.0			0.224[#]	1.0			0.894[#]

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	N	%	OR			p	OR			p
Income, 3000 to 6000	297	17.5	0.88	0.52	1.49	0.636	0.95	0.49	1.84	0.877
Income, 6001 to 9000	170	15.3	0.75	0.41	1.36	0.346	1.19	0.52	2.69	0.684
Income, >9000	109	10.1	0.47	0.22	0.99	0.048	0.91	0.34	2.45	0.859
Parents married	711	16.2	1.0				1.0			
Parents not married	14	21.4	1.41	0.39	5.15	0.600	1.57	0.38	6.47	0.533
Screen home environment										
up to 1 TV	309	12.3	1.0			0.031[#]	1.0			0.263[#]
2 TVs	236	17.8	1.54	0.96	2.49	0.074	1.60	0.91	2.82	0.105
3+ TVs	180	21.1	1.91	1.17	3.13	0.010	1.40	0.74	2.64	0.298
up to 2 mobile devices	157	10.2	1.0			0.005[#]	1.0			0.092[#]
3 mobile devices	199	13.1	1.32	0.68	2.57	0.405	1.24	0.58	2.67	0.581
4 + mobile devices	369	20.6	2.29	1.29	4.06	0.005	1.98	0.98	4.01	0.056
up to 1 computer	312	18.0	1.0			0.090[#]	1.0			0.403[#]
2 Computers	242	12.0	0.63	0.39	1.01	0.057	0.93	0.52	1.68	0.815
3+ Computers	171	19.2	1.09	0.67	1.75	0.737	1.41	0.74	2.68	0.292
0 Video consoles	504	14.3	1.0				1.0			
1+ Video consoles	221	20.8	1.58	1.05	2.38	0.029	1.06	0.64	1.76	0.827
Parental knowledge of professional recommendations										
recommend minimal viewing	91	13.2	1.0			0.002[#]	1.0			0.021[#]
recommend viewing < 2 hours/day	439	13.2	1.00	0.51	1.95	0.995	0.70	0.33	1.48	0.347

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	N	%								
recommend viewing > 2 hours/day	186	24.7	2.16	1.08	4.32	0.029	1.46	0.66	3.22	0.349
Parental screen viewing practices										
Parent SV time (lowest tertile)	238	13.0	1.0			0.004[#]	1.0			0.005[#]
Parent SV time (medium tertile)	240	12.9	0.99	0.58	1.69	0.972	0.79	0.43	1.46	0.455
Parent SV time (highest tertile)	235	23.0	1.99	1.23	3.23	0.005	1.90	1.07	3.36	0.028
Parental rule setting practices										
No rules on time and programme	178	21.9	1.0				1.0			
Rules on time and program	539	14.3	0.59	0.39	0.91	0.017	0.55	0.33	0.90	0.019

* adjusted for all other co-variables, [#] overall p-value

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Table 6 Unadjusted and adjusted associations of types of rules and strictness of rules with any screen viewing and ≥ 2 hours of screen viewing

		Any screen viewing							≥ 2 hours of screen viewing					
	N	% screen viewing	p-value	OR*	Lower 95% CI	Upper 95% CI	p-value*	N	% screen viewing	p-value	OR*	Lower 95% CI	Upper 95% CI	p-value*
Rules on program content														
Yes	583	52.3		1.0				583	16.1		1.0			
No	133	58.7	0.187	1.45	0.92	2.28	0.111	133	15.8	0.925	1.11	0.62	1.98	0.730
Rules on time														
Yes	594	50.8		1.0				594	13.8		1.0			
No	123	66.7	0.001	1.72	1.07	2.78	0.026	123	27.6	<0.001	2.33	1.37	3.98	0.002
Strictness of rules on time			<0.001#				0.003#			<0.001#				<0.001#
no rules on time	123	66.7		1.0				123	27.6		1.0			
0 hours of screen viewing	27	14.8	<0.001	0.09	0.02	0.36	0.001	**						
Less than 2 hours of screen viewing	457	52.5	0.005	0.65	0.40	1.07	0.091	484**	10.3	<0.001	0.29	0.17	0.52	<0.001
≥ 2 hours of screen viewing	110	52.7	0.031	0.50	0.27	0.94	0.031	110	31.8	0.486	0.98	0.51	1.89	0.955

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*adjusted for age, gender, ethnicity, mother's education, father's education, parental marital status, income, number of TVs, number of mobile devices, number of computers, number of video game consoles, knowledge of screen viewing recommendations, parental screen viewing, **combined categories due to n=0 screen viewing in rule category "0 screen viewing". #overall p-value

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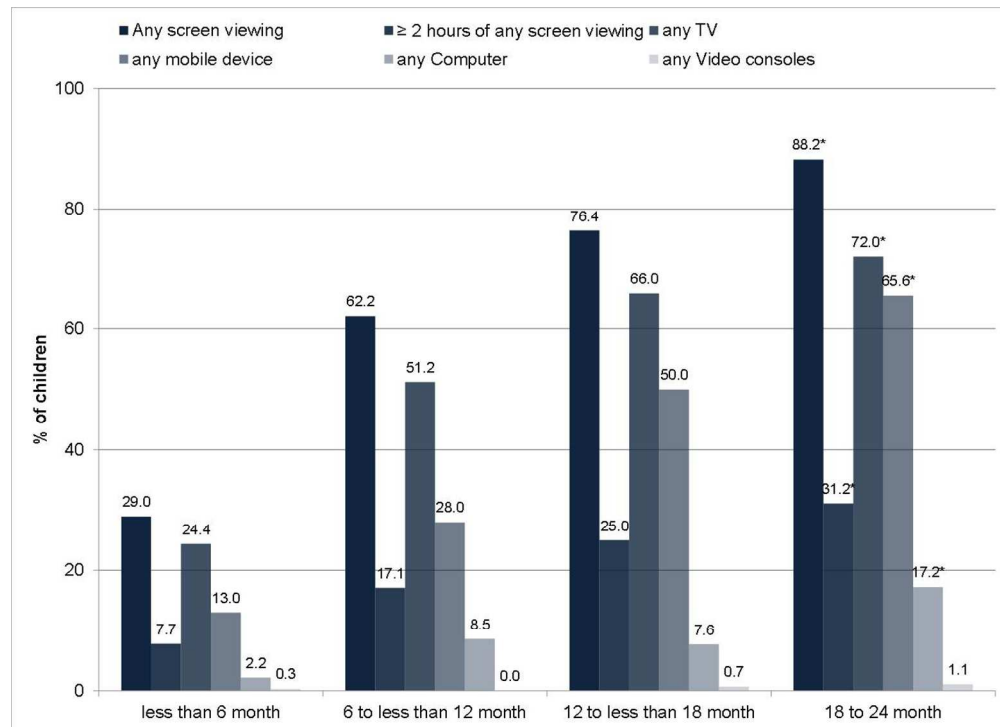
240x174mm (150 x 150 DPI)

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

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

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	8
		(c) Consider use of a flow diagram	na
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1
		(b) Indicate number of participants with missing data for each variable of interest	Table 1
Outcome data	15*	Report numbers of outcome events or summary measures	Table 2, table 3, figure 1
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Table 4, 5, and 6
		(*b*) Report category boundaries when continuous variables were categorized	7
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	na
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	na
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12,13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14
Generalisability	21	Discuss the generalisability (external validity) of the study results	12,13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	na

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

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

BMJ Open

Sociodemographic, home environment, and parental influences on total and device-specific screen viewing in children aged 2 years and below – an observational study

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2015-009113.R1
Article Type:	Research
Date Submitted by the Author:	07-Oct-2015
Complete List of Authors:	Goh, Si Ning; National University of Singapore and National University Health System, Yong Loo Lin School of Medicine Teh, Long Hua; National University of Singapore and National University Health System, Yong Loo Lin School of Medicine Tay, Wei Rong; National University of Singapore and National University Health System, Yong Loo Lin School of Medicine Anantharaman, Saradha; National University of Singapore and National University Health System, Yong Loo Lin School of Medicine Dam, Rob; National University of Singapore, Saw Swee HOck School of Public Health Tan, Chuen Seng; National University of Singapore, Saw Swee HOck School of Public Health Chua, Hwee Ling; National Healthcare Group Polyclinics, Wong, Pey Gein; National Healthcare Group Polyclinics, Müller-Riemenschneider, Falk; National University of Singapore, Saw Swee HOck School of Public Health; Charite University Medical Centre, Institute for Social Medicine, Epidemiology and Health Economics
Primary Subject Heading:	Public health
Secondary Subject Heading:	Paediatrics, Epidemiology
Keywords:	screen viewing, screen devices, infants, toddlers, prevalence, determinants

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Manuscripts

Sociodemographic, home environment, and parental influences on total and device-specific screen viewing in children aged 2 years and below – an observational study

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ABSTRACT

Objective

This study aimed to investigate total and device-specific screen viewing (SV) and its determinants in children aged two years and below.

Design

Cross-sectional study conducted in February 2014

Setting

Well-child clinics in Singapore national polyclinics.

Participants

Parents of children (Singapore citizens or permanent residents) aged two years and below were enrolled during routine clinic visits. Out of 794 eligible parent-child dyads, 725 (91.3%) provided informed consent and were included in the analysis.

Main outcome measures

Device-specific information on SV and determinants were ascertained using interviewer-administered survey questionnaires. Prevalence and duration of aggregate and device specific SV was reported. Associations with potential determinants were investigated using multiple logistic regression analysis. A p-value less than 0.05 was considered statistically significant.

Results

The prevalence of daily SV and SV ≥ 2 hours per day constituted 53.5% and 16.3%, respectively. The majority of children aged 18-24 months (88.2%) engaged in daily SV. TVs and mobile devices were the most commonly used screen devices, followed by computers and video consoles. In multivariable analysis, younger child age, Chinese ethnicity and setting rules on time of SV were strongly and consistently associated with lower levels of any SV and SV ≥ 2 hours per day. Parental knowledge of SV recommendations and less parental SV were additionally associated with lower levels of SV ≥ 2 hours per day. The number of screen devices was not associated with children's SV.

Conclusion

In contrast to recommendations, SV prevalence in children less than two years old is high and appears to increase steadily across age groups. TVs and mobile devices are most frequently used. Improving parental knowledge of SV recommendations, reducing parental SV and especially the implementation of strict rules on SV time could be successful strategies to reduce SV in young children.

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Article summary

Strengths and limitations of this study

Strengths

- This study investigates screen viewing in very young children not only considering television viewing but also other relevant up to date screen device types, such as computers, game consoles and mobile devices
- The study comprehensively assesses socio-demographic, parental and home environmental influences on screen viewing
- Our findings are based on a large multi-ethnic Asian population with very high response rate
- The study provides evidence that is highly applicable to the development of early childhood interventions aimed to reduce screen viewing

Limitations

- The main limitation is the fact that screen viewing as the main outcome was based on proxy-report and could not be determined objectively

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Background

Screen viewing (SV) has been associated with substantial detrimental health effects, including a higher risk of type 2 diabetes mellitus, cardiovascular diseases and premature mortality [1] [2]. In children, increases in the time spent on SV has been found to negatively affect cognitive and language development [3] [4], social interaction [5] [6], attention deficits [4] [7] [8], as well as behavioral problems [9-11]. SV in children has also been linked to obesity [12], metabolic risk , and impaired vision [13-15].

For children above the age of 2 years, SV recommendations, for instance from the American Academy of Pediatrics state not to engage in more than 2 hours of television (TV) or screen time per day [16]. However, recent evidence-based recommendations for very young children (here defined as children below the age of 2 years) have discouraged SV altogether [17] [18]. Despite of these recommendations, the use of screen devices in young children seems to have become common practice in recent years. For instance, in Japan, 86% of children spend over 1 hour of TV time a day by 18 months of age [19]. In Australia, the average child between 0 and 4 years spends 2.5 hours on TV [20] per day. Similarly, in the United States, 90% of children regularly watch TV or videos by age two, with average duration exceeding 1.5 hours a day [21] [22].

Such sedentary behaviors have been shown to persist across age, indicating that children who spent more time watching TV, watch more TV later in life and that these early life behaviors could be associated with adverse health consequences, such as, increased body-mass index and serum cholesterol levels, as well as decreased cardio-respiratory fitness later in life [23-26]. The increasing amount of time children spent on SV and the potential long-term implications of SV highlight the public health importance of preventing the adoption of SV behaviors early in life.

With technological advancements, screen devices have become pervasive in everyday life. Nowadays, comprehensive assessments of SV patterns in children have to consider not only TV, computer and video consoles, but also mobile screen devices, especially smart phones and tablets [16]. Their portability and ease of use anywhere and anytime could have important implications on the way these screen devices are being used. Studies in older children and adolescents have already highlighted their widespread use [27] [28]. However, little is known about current SV patterns in young children, especially with regard to the use of different screen devices [29] [30], despite the common perception that modern mobile screen devices are

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more interactive and possibly beneficial for children's health. According to a recent systematic review of the available evidence in children aged three years and below, the majority of studies reported TV and video viewing. Only five studies have reported computer use and no studies have explored mobile device use [31]. Equally important, little is known about the time when children begin to be exposed to these devices on a regular basis, their socio-demographic profile and potentially modifiable determinants. This knowledge is important to understand when and how best to prevent excessive SV behavior in children but also later in life.

This study aimed to investigate overall and device-specific SV patterns in children aged two years and below. It also investigate differences in SV behavior across age, socio-demographic factors, screen home environment, as well as parental knowledge and practice related determinants of early childhood SV.

METHODOLOGY

Participants and procedures

This was a cross-sectional study conducted in February 2014 among parents bringing their healthy children, aged two years and below, to two National Healthcare Group Polyclinics (Singapore has a total of 18 polyclinics) for their well child health visits, which may include developmental assessment and/or vaccinations. The take up rate of this Program for children up to two years is more than 97%, providing a good representation of the children in the region at a given point in time [32]. Parents satisfying the eligibility criteria were invited to participate in the study. Participants who were not Singapore citizens were excluded and verbal consent from the participants was obtained. After consent was obtained, trained interviewers administered survey questionnaires in a standardized form in the participants' preferred language (English, Chinese, Malay, and Tamil) during clinic visits.

This study was approved by the Singapore National Health Care Group Domain Speific Review Boards (DSRBs). Participation was entirely voluntary and informed consent was received from all the parents or caregivers.

Measurements

The study questionnaire was developed following comprehensive literature review and refined through pilot studies. Interviewers were trained to ensure consistent administration of the survey questionnaires.

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Screen viewing (SV) behavior

Parents were asked to provide information about the amount of screen time their child was exposed to during weekdays and weekends. Parental recall of their child's SV time has been shown to be reliable, correlating well within previous observational studies [33]. SV behavior was ascertained in four broad device categories: TV/Digital Video Disc (DVD), computer, video game consoles and mobile devices (including smart phones, tablets and other portable devices). To determine total SV, the amount of time spent on individual device categories was added up for weekdays and weekends with weights corresponding to 5/7 and 2/7, respectively. Subsequently total SV time during the entire week was calculated. Each device specific SV time was determined in the same way but only including information for respective devices.

Two SV statuses are presented, 1. "any SV per day", and 2. "SV ≥ 2 hours per day" on any device, as well as for different screen devices. The second SV status is based on previously cited SV recommendations, that indicate that even older children should not engage in more than 2 hours of SV per day. We therefore chose this cut-off to indicate "heavy" SV exposure.

Independent variables

Socio-demographic information of the parent was recorded, including ethnicity, parents' education, parental marital status, and household income, together with the child's age and gender. The screen environment at home was determined by assessing the number of functioning screen devices at home. The number of screen devices was recorded separately for each device type. Parental knowledge of professional SV recommendations for children under the age of two years was categorized into three categories: minimize SV altogether, less than 2 hours of SV time, and ≥ 2 hours of SV time. Parental SV was determined and summarized in the same way as for children. Total parental SV time was categorized according to tertiles.

Parental rule setting practices focused on whether parents set rules on the time (duration per day) and the program (content) of their child's SV, respectively. These variables were combined (parents that set rules on both time and type of program

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versus parents who did not set rules on time and program) because of the strong association between both variables. The exact daily SV time permitted according to parental rules was further assessed and categorized into four groups: "no SV rules", "SV time ≥ 2 hours" rule, "SV time of less than 2 hours" rule, and "no SV time" rule.

Data analysis

For categorical variables, counts and percentages were reported while for continuous variable, the median and interquartile ranges (IQR) were reported. To assess association between categorical variables, the Chi-square or Fisher exact tests were used where appropriate. The Kruskal-wallis test was used to assess association between continuous and categorical variables. Multiple logistic regression was used to model two representations of SV status, "any SV per day" and "SV of ≥ 2 hours per day" (representing "heavy users"), where socio-demographic factors, parental knowledge and practices were the independent variables. In these analyses, both rule setting characteristics (time and program) were combined as "parents that set rules on time and type of program". To further explore the association with specific types of rules and the strictness of rules on time (with regard to the permitted duration of SV per day), multiple logistic regression analysis was performed separately for "rules on time", "rules on program", and the strictness of rules on time in terms of the permitted SV time. The odds ratio (OR), its 95% confidence interval (95%CI) and p-values were reported. A p-value <0.05 was considered statistically significant. The statistical analysis was carried out using IBM Statistical Package for Social Sciences and Stata 12.

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RESULTS

Study population

All 1061 parent-child dyads visiting the assessment sites during the assessment periods were approached. Of them, 794 met the inclusion criteria and 725 (91.3%) provided consent, participated in the survey and provided complete information on the outcome variables of SV time.

Child and parental characteristics of the study population are presented in Table 1. Findings show that 55.3% of children were male and the majority (58.6%) were of Chinese ethnicity with the remainder being mostly of Malay or Indian ethnicity. The median age of the children was 7 (IQR: 10) months with 44.7% being younger than 6 months and 55.3% being 6-24 months old. Majority of the parents were married (98.1%) where 79.5% of fathers and 76.0% of mothers had attained an educational level of post-secondary school and above. The majority of the households (81.1%) had a monthly income of 3000 SGD (where 3000 SGD is approximately 2011 USD) or more.

The most common screen devices in households were mobile devices with a median of 4 devices per household, followed by TVs and computer. Video game consoles were considerably less common. With regard to the knowledge about professional SV recommendations, only 12.7% of parents were aware that SV in children below the age of two should be minimized and almost twice as many parents (26%) believed that the recommended duration was 2 hours or more per day is recommended by guidelines. About 80% of parents set rules on time or program of SV, and about 75% set rules on both time and program. Although more than 10% of parents appeared to know that SV shold be minimized according to professional SV recommendations, less than 5% among parents set rules to minimize SV. More than 75% of parents with rules on SV time set rules of less than 2 hours SV per day (or 63% among all 725 parents).

Screen viewing behavior

The prevalence of daily SV among children is presented in detail in Table 2. Overall prevalence of daily SV was 53.5%, with TVs being most widely used (44.8%), followed by mobile devices (30.5%), computers (6.6%) and video game consoles (0.4%). The prevalence of daily SV of 2 hours or more per day across all devices

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was 16.3%, and the prevalence for TV, mobile device, computer and video game console viewing were 11.4%, 3.9%, 1.0% and 0.0% respectively.

Figure 1 presents the prevalence of daily total SV and by device, as well as SV 2 hours or more per day across 6 month age groups. Among children younger than 6 months, any daily SV activity was reported in 29%, and a higher prevalence was reported with increasing age, being 88.2% at age 18-24 months. Differences between age groups and SV status across all devices and each device (apart from video consoles) were statistically significant. In all age groups, TV viewing was the most common form of SV behavior, followed by mobile devices, computers and video game consoles. The difference in prevalence of SV between TV and mobile device was less pronounced at age 18-24 months as compared with the younger age groups.

In those with any SV activity (Table 3) median total SV was 60.0 (IQR: 95.7) minutes per day among children aged less than 6 months. It was 80 (IQR: 120) minutes per day in those aged 18 to 24 months (p=0.0004). SV aggregated across devices was significantly higher at older age (p=0.0004), but when investigating different devices a statistically significant difference was only observed for mobile devices.

Socio-demographic, screen home environmental, parental knowledge and practice correlates of SV in children

In unadjusted analysis, increased child age, Malay and Indian ethnicity and lower maternal educational level were significantly associated with higher prevalence of any daily SV behaviour among the socio-demographic variables (Table 4). The screen home environment was not significantly associated with screen viewing behaviour and a borderline significant association between lack of parental knowledge of professional SV recommendations and higher prevalence of any daily SV behavior was found. With regard to practices, parental SV was not significantly associated with daily SV behaviour but the absence of rule setting practices were significantly associated with higher prevalence of any SV activity among children.

When controlling for all other variables, older children (OR: 8.07, 95% CI: 5.57 to 11.69), and children with Malay (OR: 2.72, 95% CI: 1.73 to 4.28), Indian (OR: 2.53, 95% CI: 1.39 to 4.61), other ethnicities (OR: 3.19, 95% CI: 1.13 to 9.05) had a

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significantly increased odds of daily SV. Among home environmental variables, parents who reported having two TV's were significantly more likely to report screen viewing in their children (OR: 1.57, 95% CI: 1.03 to 2.40). Although the association between knowledge of SV recommendations and children engaging in any SV was insignificant, parents who believed that guidelines recommend more than 2 hours of SV had a significant greater odds of engaging in any SV (OR: 1.84, 95% CI: 1.00 to 3.39). Similarly, children of parents who specified screen time rules had a significant reduced odds of any SV activity (OR: 0.65, 95% CI: 0.43 to 0.98).

As presented in Table 5, observed associations with regards to 2 or more hours of SV per day were similar for socio-demographic variables. However, associations with parental knowledge, parental SV and parental rule setting were more consistently and more strongly associated with viewing two or more hours per day as compared to any daily SV. The screen home environment had devices with significant associations in the unadjusted analysis. Specifically, greater number of TVs, mobile devices and video game console were significantly associated with higher prevalence of SV time 2 or more hours. However, they become insignificant in the adjusted analysis. Different from Table 4, incorrect parental belief on SV recommendations and higher parental SV time were significantly associated with higher prevalence of SV time 2 or more hours. Moreover, rule setting practices were significantly associated with lower SV. These significant findings persisted after adjustment.

Association of rule setting type and strictness with SV

Table 6 presents unadjusted and adjusted associations of rule setting practices with any SV and SV of ≥ 2 hours per day. Regardless of the SV outcome and adjustment "rules on program" were not significantly associated with SV in young children. On the contrary, "rules on time" were consistently associated with a lower likelihood of any SV and SV of ≥ 2 hours per day. Moreover, stricter rules on SV time were consistently associated with lower levels of any SV and SV of ≥ 2 hours per day.

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DISCUSSION

This study investigated SV patterns and their correlates in very young children, considering multiple different screen device types, including TV, computer, but also mobile screen devices and video game consoles. Given the widespread use, especially of mobile screen devices in day to day life, this comprehensive approach is important to fully understand SV patterns. Based on a recent systematic review of the literature, this study is the first in young children to investigate SV patterns and their correlates in such detail [31].

Our findings show that among children up to the age of two, SV on a daily basis is very common. Even in children aged less than 6 month, about 30 percent were engaging daily in SV and by the age of 18-24 months, about 90% of children engaged in daily SV activities. We made similar observations with regard to SV time, so that by the age of 18-24 months the median SV time was almost 1.5 hours per day and almost 1/3 of the children were engaging in 2 or more hours of SV time per day. Our findings are consistent with research from other countries that have previously reported high exposure to TV, computer and videos at young ages [22].

Although TVs still appear to be the most common form of screen devices young children are exposed to, our findings also highlight that TVs are not the only relevant screen device children are using. Mobile devices have become widely available in the entire population and they now seem to reflect the second most important source of SV in very young children. Furthermore, we noted that the difference in the prevalence between TV and mobile devices is least pronounced at the age of 18 to 24 months when compared with younger age groups making SV attributable to mobile devices comparable with TVs. Moreover, in terms of the SV time, we noted a significant difference across age groups for total SV and mobile devices but not for TVs or other screen devices. Previous studies from the US and Europe, targeting older children, have also reported on the frequent use of mobile devices. In addition, recent discussions in the scientific literature have addressed the potential health implications of the widespread use of modern mobile screen devices in very young children, but our study appears to be among the first to comprehensively quantify patterns and relevant correlates in this population [27 29 30].

Besides age, we noted that Malay, Indian and other ethnic groups were considerably more likely to engage in any SV and two or more hours of SV per day as compared to Chinese. This is consistent with existing literature that also reported ethnic

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differences in SV in Western populations [31] [34]. On the other hand, we did not identify significant associations between daily SV or SV of two or more hours per day and other socio-demographic variables, such as child's gender, mother's or father's educational level, income, and parental marital status when taking potential confounders into consideration [31].

Parental knowledge and parenting practices may have the potential to reflect targets for health promotion strategies to reduce or delay the update of SV in very young children. Our study found strong and consistent associations between child SV and parental rule setting practices. Findings indicate that children are less likely to engage in SV if parents set rules on SV time, and additionally if the rules on SV time are stricter. On the other hand, rules on programs did not appear to be significantly associated with SV in children. A recent systematic review of the literature reported mixed and less consistent findings of such TV policies at home. However, this review summarized studies of very different methodology and importantly mostly targeting older children and adolescents. Only two of the included studies had focused on children below the age of two, and they only concentrated on TV viewing [35-37]. Our findings are similar to previous research in older children, however, that also indicated that the type of rules (time or program) may have implications in terms of SV [37]. In addition to rule setting practices, knowledge of professional screen viewing recommendations and parental screen viewing behaviour were significantly associated with screen viewing in children, particularly with viewing 2 or more hours per day. These findings seem to be consistent with studies conducted in older children and adolescents that reported associations between children's and parental screen viewing [27] [31] [38].

Our study has a number of strength, including a very high participation rate and detailed outcome assessments. Building on Singapore's National Childhood Immunization program facilitated this study of a defined population of healthy children aged two and below. Some limitations have to be acknowledged, though. First, the survey recruited from two out of the eighteen polyclinics covering the whole of Singapore. Variations in the overall population reflected in the other centers may hence be unaccounted for. Second, this is a cross-sectional study which limits its ability to draw inferences about the direction of cause and effect. However, modern screen devices, in particular tablets, have only become widely used after the launch of the Ipad in 2010. Hence, at this stage longitudinal data on the use and

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determinants of modern screen devices is not available. Third, the study was conducted in February and may not reflect seasonal variations in screen time exposure, although seasonal variation in weather is limited in tropical Singapore. Fourth, our study relied on proxy-report. While questionnaires were developed based on existing literature and extensively piloted, they were not validated and we were not able to determine SV objectively. This could introduce measurement bias. Finally, we did not distinguish between the type of program screen time was spent on or whether it was for instance spend for video calling with family members. This will be important to consider in future studies because research has indicated that health consequences may vary depending on the activity performed [39].

Our findings have considerable public health implications because they highlight the importance of targeting SV practices at a very early age, ideally even during the first six months of life in order to develop appropriate practices to prevent the update of these activities in the first place. Our study also showed that TV viewing still seems to be the most common but not the only relevant screen device young children are exposed to. With increasing age, mobile devices take up an increasing part of total screen viewing time and by the age of 18 to 24 months almost as prevalent as TVs. Different devices may require different intervention strategies and recommendations, given their portability, small size and multifunctional usability (eg. watching videos, playing games, reading, listening to audio books). We were able to identify a number of potentially modifiable factors that were strongly associated with SV practices in children, including parental knowledge of professional SV recommendations, parental SV and rule setting practices, and to a lesser degree the number of devices in the household, These findings were particularly present in the case of heavy SV, which suggests that reducing SV behavior in young children might be an achievable target, while replacing SV entirely could be more challenging. Modifiable factors offer opportunities for health promotion strategies, administered for instance by health care professionals during developmental assessments or teachers in child care centers at a very young age. This could help to delay and reduce screen viewing in children. Our findings are consistent with earlier publications that reported a high prevalence of regular TV viewing in very young children [19 20 22 40]. However, our findings expand the existing literature considerably in various aspects. Importantly, we were able to investigate multiple up to date screen device types and a broad spectrum of socio-demographic, environmental, parental knowledge and practices

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related correlates of screen viewing in very young children. In addition, literature reviews have shown that the bulk of the existing evidence comes from the US and Europe, with a very limited number of studies from Asian countries, despite the rapid economic development and increasing concerns about the increase in non-communicable diseases [31].

In conclusion, our study found a high prevalence of SV overall. Within the first two years of a child´s life the prevalence of SV increased across age groups. By the age of two years almost all children were exposed to screen devices daily and a substantial proportion of this young study population exceeded two hours of SV, usually recommended as the maximum for much older children. While TV viewing remains the most common contributor to overall SV in children, our findings also confirm the increasingly important role of mobile screen devices. Strategies aimed to reduce the rapid uptake of regular SV practices in children are urgently needed to influence future behaviours and health. We were able to identify potential targets for such strategies, especially for SV or 2 or more hours per day, including parental knowledge regarding professional SV recommendations, parental SV practices and the implementation of strict rules on SV time in young children.

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Authors' contributions

SNG, LHT, WRT, and SA, conceptualized and carried out the study and contributed towards drafting the manuscript. FMR contributed towards conceptualization of the study, performed the statistical analysis, and drafted the manuscript. All other authors contributed towards conceptualization of the study and critically revised the manuscript. All authors read and approved the final manuscript.

Competing interests: The author(s) declare that they have no competing **interests.**

Data sharing statement: No additional data are available

Figure legend

Figure 1 Prevalence of screen viewing behaviour overall and according to device type according to 6 month age groups (n=725). *Difference across age groups, p<0.001.

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Table 1 Participant, child and household characteristics (n=725)

	N per group	% of total
Socio-demographic characteristics		
Male	401	55.3
Female	324	44.7
< 6 month	324	44.7
6-24 month	401	55.3
Age in months (median, IQR)	725	7.0 (10.0)
Chinese	425	58.6
Malay	196	27.0
Indian	82	11.3
Other	22	3.0
Parents not married	14	1.9
Parents married	711	98.1
Mother education (primary/secondary)	174	24.0
Mother education (postsecondary and above)	551	76.0
Father education (primary/secondary)	148	20.5
Father education (postsecondary and above)	575	79.5
Income, <3000 SGD	134	18.9
Income, 3000 to 6000 SGD	297	41.8
Income, 6001 to 9000 SGD	170	23.9
Income, >9000 SGD	109	15.4
Screen home environment		
Number of TVs, (median, IQR)	725	2 (1)
Number of mobile devices, (median, IQR)	725	4 (2)
Number of Computers, (median, IQR)	725	2 (1)
Number of Video Consoles, (median, IQR)	725	0 (1)
Parental knowledge of professional screen viewing recommendations		
recommend minimal viewing	91	12.7

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recommend viewing < 2 hours/day	439	61.3
recommend viewing ≥ 2 hours/day	186	26.0
Parental screen viewing practices		
Parent screen time, hours/day (median, IQR)	713	8.0 (7.7)
Parental rule setting practices		
Rules on time	594	82.9
Rules on program content	583	81.4
Rules on time and program	539	75.2
Rules on time*, no screen time	27	4.6
Rules on time,* less than 2 hours	457	76.9
Rules on time*, ≥ 2 hours	110	18.5

*Based on participants who set rules on screen viewing time (n=594)

Table 2 Total and device-specific screen viewing (n=725)

	no screen viewing		up to 2 hours of screen viewing		≥ 2 hours of screen viewing	
	N	%	N	%	N	%
Total screen time	337	46.5	270	37.2	118	16.3
TV	400	55.2	242	33.4	83	11.4
Mobile device	504	69.5	193	26.6	28	3.9
Computer	677	93.4	41	5.7	7	1.0
Video game console	722	99.6	3	0.4	0	0.0

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Table 3 Screen viewing according to age groups and median screen viewing time among children who are exposed to screen devices

	<6 months (n=324)				6 to <12 (n=164)				12 to <18 (n=144)				18 to 24 month (n=93)				
	N	%	Median	IQR	N	%	Median	IQR	N	%	Median	IQR	N	%	Median	IQR	p-value*
Total screen time	94	29.0	60.0	95.7	102	62.2	60.0	90.0	110	76.4	70.0	122.1	82	88.2	80.0	120.0	0.0004
TV	79	24.4	45.0	81.4	84	51.2	51.4	97.1	95	66.0	60.0	98.6	67	72.0	60.0	72.9	0.5820
Mobile device	42	13.0	23.2	49.3	46	28.0	23.6	22.1	72	50.0	32.1	45.0	61	65.6	40.0	30.0	0.0004
Computer	7	2.2	21.4	32.9	14	8.5	30.0	32.9	11	7.6	30.0	45.0	16	17.2	43.9	75.0	0.0876
Video consoles	1	0.3	5.7	0.0	0	0.0	-	-	1	0.7	60.0	0.0	1	1.1	10.0	0.0	0.3679

*for comparison of median screen viewing across age groups

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Table 4 Unadjusted and adjusted associations between any SV activity and socio-demographic, home-environment, parental knowledge and practices

	N	% screen viewing	Unadjusted Model				Multivariable Model*			
			OR	Lower 95% CI	Upper 95% CI	p-value	OR*	Lower 95% CI	Upper 95% CI	p-value*
Sociodemographic characteristics										
Age, < 6 month	324	29.0	1.0				1.0			
Age, > 6 month	401	73.3	6.72	4.85	9.32	<0.001	8.07	5.57	11.69	<0.001
Chinese	425	46.6	1.0			<0.001[#]	1.0			<0.001[#]
Malay	196	65.3	2.16	1.52	3.06	<0.001	2.72	1.73	4.28	<0.001
Indian	82	58.5	1.62	1.00	2.61	0.049	2.53	1.39	4.61	0.002
Others	22	63.6	2.01	0.82	4.88	0.125	3.19	1.13	9.05	0.029
Male	401	55.1	1.0				1.0			
Female	324	51.5	0.87	0.65	1.16	0.338	0.93	0.65	1.32	0.686
Mother education (primary/secondary)	174	60.9	1.0				1.0			
Mother education (postsecondary)	551	51.2	0.67	0.48	0.95	0.025	0.70	0.42	1.16	0.167
father education (primary/secondary)	148	59.5	1.0				1.0			
Father education (postsecondary)	575	51.8	0.73	0.51	1.06	0.098	1.00	0.60	1.66	0.993
Income, <3000	134	58.2	1.0			0.278[#]	1.0			0.929[#]
Income, 3000 to 6000	297	54.2	0.85	0.56	1.28	0.439	0.96	0.57	1.62	0.882

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	N	%	OR			p	OR			p
Income, 6001 to 9000	170	52.4	0.79	0.50	1.25	0.309	1.11	0.59	2.08	0.755
Income, >9000	109	45.9	0.61	0.37	1.01	0.056	0.94	0.47	1.90	0.866
Parents married	711	53.3	1.0				1.0			
Parents not married	14	64.3	1.58	0.52	4.75	0.418	1.85	0.52	6.62	0.343
Screen home environment										
up to 1 TV	309	49.5	1.0			0.176[#]	1.0			0.111[#]
2 TVs	236	56.8	1.34	0.95	1.88	0.093	1.57	1.03	2.40	0.036
3+ TVs	180	56.1	1.30	0.90	1.89	0.159	1.29	0.79	2.10	0.315
up to 2 mobile devices	157	47.8	1.0			0.265[#]	1.0			0.326[#]
3 mobile devices	199	55.3	1.35	0.89	2.06	0.160	1.47	0.89	2.45	0.135
4 + mobile devices	369	55.0	1.34	0.92	1.94	0.128	1.26	0.77	2.07	0.352
up to 1 computer	312	58.3	1.0			0.078[#]	1.0			0.892[#]
2 Computers	242	49.8	0.71	0.51	0.99	0.046	1.10	0.72	1.70	0.656
3+ Computers	171	50.0	0.71	0.49	1.04	0.078	1.02	0.61	1.70	0.939
0 Video consoles	504	53.0	1.0				1.0			
1+ Video consoles	221	54.8	1.07	0.78	1.48	0.659	1.04	0.69	1.56	0.863
Parental knowledge of professional recommendations										
recommend minimal viewing	91	41.8	1.0			0.058[#]	1.0			0.145[#]
recommend viewing < 2 hours/day	439	55.1	1.71	1.08	2.71	0.021	1.45	0.85	2.46	0.172

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	N	%	OR	CI	CI	p-value	OR*	CI	CI	p-value
recommend viewing > 2 hours/day	186	55.4	1.73	1.04	2.87	0.034	1.84	1.00	3.39	0.049
Parental screen viewing practices										
Parent screen time (lowest tertile)	238	55.9	1.0			0.357[#]	1.0			0.430[#]
Parent screen (medium tertile)	240	55.0	0.96	0.67	1.38	0.846	0.88	0.57	1.36	0.568
Parent screen time (highest tertile)	235	49.8	0.78	0.55	1.12	0.185	0.75	0.48	1.16	0.196
Parental rule setting practices										
No rules on time and programme	178	60.7	1.0				1.0			
Rules on time and program	539	51.2	0.68	0.48	0.96	0.029	0.65	0.43	0.98	0.041

* adjusted for all other co-variables, [#] overall p-value

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Table 5 Unadjusted and adjusted associations between SV time per day ≥ 2 hours and socio-demographic, home-environment, parental knowledge and practices

	N	% screen viewing	Unadjusted Model				Multivariable Model*			
			OR	Lower 95% CI	Upper 95% CI	p-value	OR	Lower 95% CI	Upper 95% CI	p-value
Sociodemographic characteristics										
Age, < 6 month	324	7.7	1.0				1.0			
Age, > 6 month	401	23.2	3.61	2.26	5.77	<0.001	4.88	2.87	8.31	<0.001
Chinese	425	9.7	1.0			<0.001[#]	1.0			<0.001[#]
Malay	196	28.1	3.65	2.33	5.72	<0.001	3.93	2.26	6.85	<0.001
Indian	82	19.5	2.27	1.20	4.28	0.011	4.14	1.88	9.12	<0.001
Others	22	27.3	3.51	1.30	9.47	0.013	5.39	1.70	17.08	0.004
Male	401	17.5	1.0				1.0			
Female	324	14.8	0.82	0.55	1.23	0.339	0.80	0.50	1.28	0.353
mother education (primary/secondary)	174	21.8	1.0				1.0			
mother education (postsecondary)	551	14.5	0.61	0.40	0.94	0.024	0.68	0.37	1.27	0.227
father education (primary/secondary)	148	21.0	1.0				1.0			
Father education (postsecondary)	575	15.1	0.67	0.43	1.06	0.089	0.90	0.49	1.66	0.737
Income, <3000	134	19.4	1.0			0.224[#]	1.0			0.894[#]

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Income, 3000 to 6000	297	17.5	0.88	0.52	1.49	0.636	0.95	0.49	1.84	0.877
Income, 6001 to 9000	170	15.3	0.75	0.41	1.36	0.346	1.19	0.52	2.69	0.684
Income, >9000	109	10.1	0.47	0.22	0.99	0.048	0.91	0.34	2.45	0.859
Parents married	711	16.2	1.0				1.0			
Parents not married	14	21.4	1.41	0.39	5.15	0.600	1.57	0.38	6.47	0.533
Screen home environment										
up to 1 TV	309	12.3	1.0			0.031[#]	1.0			0.263[#]
2 TVs	236	17.8	1.54	0.96	2.49	0.074	1.60	0.91	2.82	0.105
3+ TVs	180	21.1	1.91	1.17	3.13	0.010	1.40	0.74	2.64	0.298
up to 2 mobile devices	157	10.2	1.0			0.005[#]	1.0			0.092[#]
3 mobile devices	199	13.1	1.32	0.68	2.57	0.405	1.24	0.58	2.67	0.581
4 + mobile devices	369	20.6	2.29	1.29	4.06	0.005	1.98	0.98	4.01	0.056
up to 1 computer	312	18.0	1.0			0.090[#]	1.0			0.403[#]
2 Computers	242	12.0	0.63	0.39	1.01	0.057	0.93	0.52	1.68	0.815
3+ Computers	171	19.2	1.09	0.67	1.75	0.737	1.41	0.74	2.68	0.292
0 Video consoles	504	14.3	1.0				1.0			
1+ Video consoles	221	20.8	1.58	1.05	2.38	0.029	1.06	0.64	1.76	0.827
Parental knowledge of professional recommendations										
recommend minimal viewing	91	13.2	1.0			0.002[#]	1.0			0.021[#]
recommend viewing < 2 hours/day	439	13.2	1.00	0.51	1.95	0.995	0.70	0.33	1.48	0.347

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	N	%	OR			p	OR*			p
recommend viewing > 2 hours/day	186	24.7	2.16	1.08	4.32	0.029	1.46	0.66	3.22	0.349
Parental screen viewing practices										
Parent SV time (lowest tertile)	238	13.0	1.0			0.004[#]	1.0			0.005[#]
Parent SV time (medium tertile)	240	12.9	0.99	0.58	1.69	0.972	0.79	0.43	1.46	0.455
Parent SV time (highest tertile)	235	23.0	1.99	1.23	3.23	0.005	1.90	1.07	3.36	0.028
Parental rule setting practices										
No rules on time and programme	178	21.9	1.0				1.0			
Rules on time and program	539	14.3	0.59	0.39	0.91	0.017	0.55	0.33	0.90	0.019

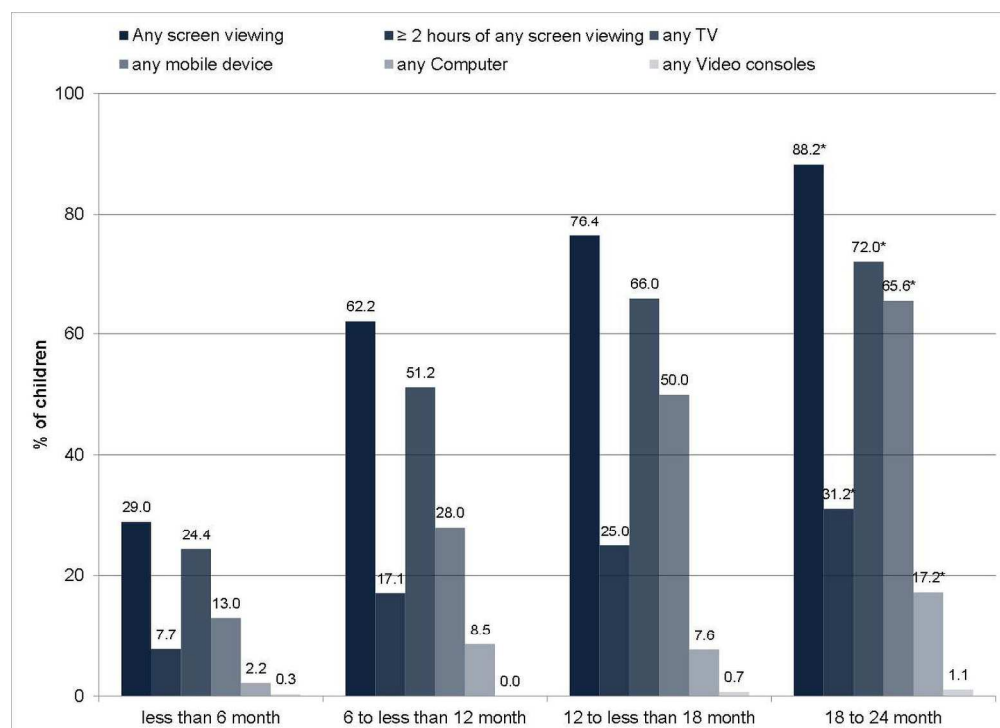* adjusted for all other co-variables, [#] overall p-value

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Table 6 Unadjusted and adjusted associations of types of rules and strictness of rules with any screen viewing and ≥ 2 hours of screen viewing

			Any screen viewing						≥ 2 hours of screen viewing					
	N	% screen viewing	p-value	OR*	Lower 95% CI	Upper 95% CI	p-value*	N	% screen viewing	p-value	OR*	Lower 95% CI	Upper 95% CI	p-value*
Rules on program content														
Yes	583	52.3		1.0				583	16.1		1.0			
No	133	58.7	0.187	1.45	0.92	2.28	0.111	133	15.8	0.925	1.11	0.62	1.98	0.730
Rules on time														
Yes	594	50.8		1.0				594	13.8		1.0			
No	123	66.7	0.001	1.72	1.07	2.78	0.026	123	27.6	<0.001	2.33	1.37	3.98	0.002
Strictness of rules on time			<0.001[#]				0.003[#]			<0.001[#]				<0.001[#]
no rules on time	123	66.7		1.0				123	27.6		1.0			
0 hours of screen viewing	27	14.8	<0.001	0.09	0.02	0.36	0.001	**						
Less than 2 hours of screen viewing	457	52.5	0.005	0.65	0.40	1.07	0.091	484**	10.3	<0.001	0.29	0.17	0.52	<0.001
≥ 2 hours of screen viewing	110	52.7	0.031	0.50	0.27	0.94	0.031	110	31.8	0.486	0.98	0.51	1.89	0.955

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*adjusted for age, gender, ethnicity, mother's education, father's education, parental marital status, income, number of TVs, number of mobile devices, number of computers, number of video game consoles, knowledge of screen viewing recommendations, parental screen viewing, **combined categories due to n=0 screen viewing in rule category "0 screen viewing". #overall p-value

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

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

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	8
		(c) Consider use of a flow diagram	na
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1
		(b) Indicate number of participants with missing data for each variable of interest	Table 1
Outcome data	15*	Report numbers of outcome events or summary measures	Table 2, table 3, figure 1
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Table 4, 5, and 6
		(*b*) Report category boundaries when continuous variables were categorized	7
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	na
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	na
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12,13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14
Generalisability	21	Discuss the generalisability (external validity) of the study results	12,13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	na

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

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