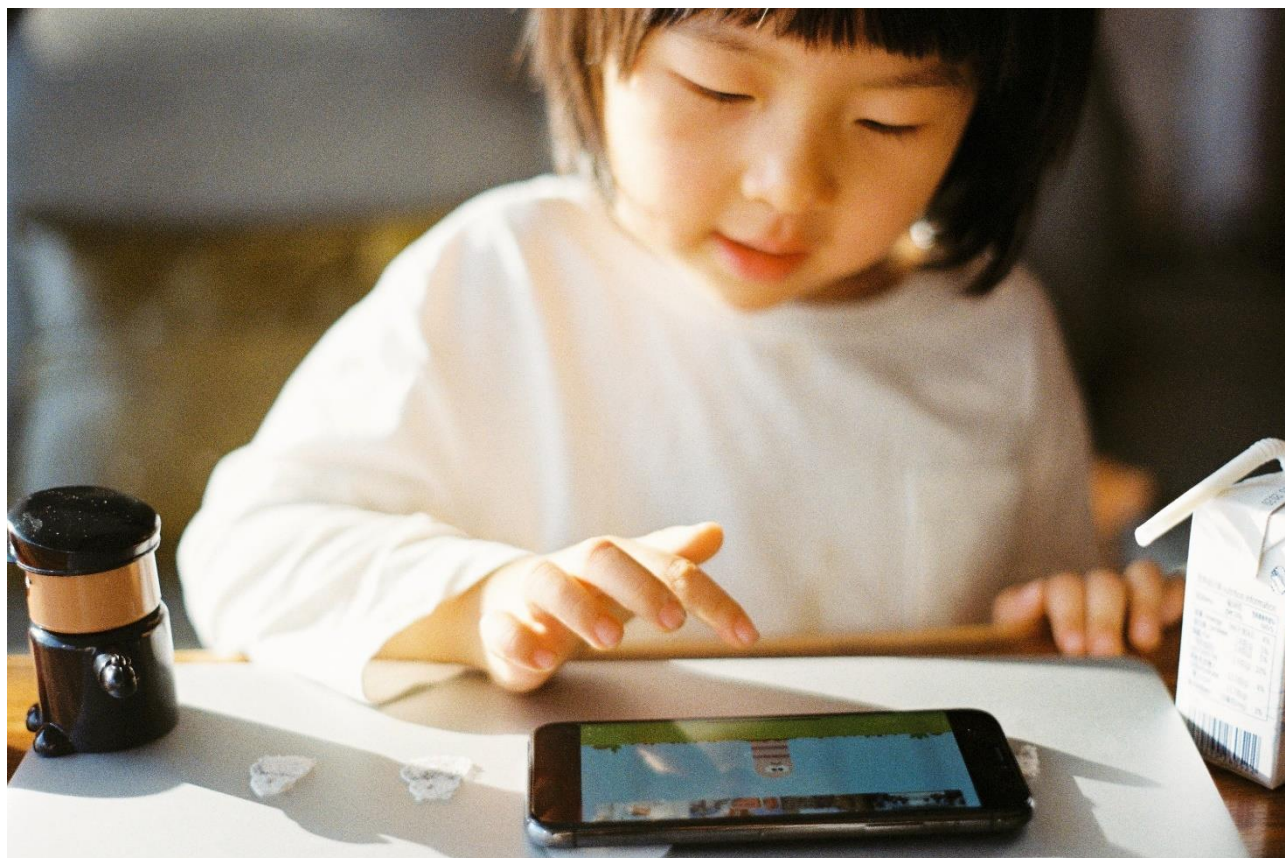




Evidence Review of Screen Use in Childhood

Lewis R, Yap CH J (2022) Evidence Review of Screen Use in Childhood. Saw Swee Hock School of Public Health. National University of Singapore. 20 February 2023.

SUMMARY

The availability of screens and their uses have rapidly expanded over recent years. Children use screens now more than ever and as children age, they increase the time that they spend on screens and often have their own screens.

Since the pandemic lockdowns there has been an inevitable further increase in children using screens.

There has been debate around what is “normal” and “abnormal” (or excessive and pathological) screen use. Defining boundaries is challenging as behavioural patterns and the extent of use vary widely between individuals and cultures.

Children can benefit from screen use, such as when there is co-viewing with the family and interaction around content. Older children can also maintain and develop friendships online and use educational games and resources.

There are potential downsides to screen use, particularly in very young children. Much of the evidence to date has significant limitations. However, there do appear to be associations between screen use and insufficient good quality sleep, sedentary behaviours, obesity, and mental health and well-being.

These potential negative impacts are interconnected and link directly to how a child spends the rest of their day as screen time can displace other activities. The inter-relatedness of sedentary behaviour (of which screen time is one), sleep and physical activity has led to several international guidelines taking a holistic “healthy day” approach.

The World Health Organization (WHO), American, Canadian, Australian, New Zealand, German, Asia-Pacific, and Singaporean guidelines take a whole day approach. Within them are sedentary time guidelines, and screen time guidance as one component. These guidelines generally coalesce around age banding and recommending:

- No screen time at all for children under 2 years old.
- No more than 1 hours a day for pre-schoolers.
- No more than 2 hours a day for school aged children and adolescents.

There is weak evidence to support specific time limits on screens. Most children across multiple countries fail to meet recommended guidance. It could be considered that setting time limits on screen use is setting up parents and children to fail. Guidance does not consider type of screen use or content.

Taiwan and China have stricter rules in screen time limits with legal obligations to comply.

Taiwan states that children under 2 years old should not use screens at all. 3 year olds should be limited to only 30 minutes of screen time per day. 4 to 6 year olds should be limited to one hour, with a 10-minute break every half hour to rest their eyes.

China states that children should be limited to just three hours of online game playing a week (one hour between 8pm - 9pm on Friday, Saturday and Sunday). Children have found workarounds to these rules or use screens to do other activities.

Screen time guidelines with a focus on setting specific time limits on exposure might be too simplistic.¹ In addition, not all screens and screen content are equal, making specific time limits challenging to advise.

Based on an analysis of the evidence the United Kingdom has a primary recommendation that families should negotiate screen time limits with their children based upon the needs of an individual child, the ways in which screens are used and the degree to which use of screens appears to displace (or not) physical and social activities and sleep. The UK has also adopted the expert recommendation that screens are avoided for an hour before the planned bedtime. The primary recommendation is based on the analysis that there is little evidence that any specific intervention or time limits can be applied across the population to reduce screen time. Instead, four key questions have been developed for families to use as a guide to examine their screen time:

1. Is screen time in your household controlled?
2. Does screen use interfere with what your family want to do?
3. Does screen use interfere with sleep?
4. Are you able to control snacking during screen time?

There are commonalities across many of the international guidelines around switching off screens an hour before bed and designing times (while having dinner as a family) and locations (the bedroom) that are designated screen-free. There is evidence that this will improve social interaction and sleep, respectively.

Interventions focused on reducing screen time often only reduce duration of screen use by a relatively small amount of time (eg less than 30 minutes a day). Small changes in sedentary behaviour could be important as it may lead to increased interaction, physical activity or sleep, with associated benefits to childhood development.

Research is in its infancy, but more effective interventions may include a focus on the following aspects:

- Early Childhood: Develop positive habits as early as possible in childhood.
- Parental Involvement: Develop parental capability and confidence to set goals with children, provide motivation for children to make habit changes (eg 'earned screen time') and be good role-models (eg for screen use, sleep behaviours and physical activity).
- Whole Day: Interventions should seek to incorporate advice and guidance on sedentary behaviour (of which screen time is just one), sleep behaviour, and physical activity, as well as guidance on diet and social and emotional aspects.
- Public Health Programmes: Addressing behavioural change in children and adolescents are most effective when used as a comprehensive and multifaceted strategy rather than a singular-component intervention.

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INTRODUCTION

The availability of screens and their uses have rapidly expanded over recent years. Home-based television viewing used to be the main screen time. Screen use has now expanded to computers, game consoles, and mobile digital devices such as smartphones and tablets.²

With the proliferation of different types of screens and content has come changes to how people use and experience screens. There is now interactivity with the screen, solitary viewing, simultaneous screen use ('screen stacking'), viewing outside of the home, and so on.^{2,3} Not all screens are equal and comparisons across screen use are challenging.

Screens are ubiquitous in today's world and technology continues to evolve at speed. The scale of change challenges public health researchers, policy-makers, teachers, and care givers as to what is the 'right' amount of screen time for children at different ages as well as the type of screen and type of content.

Screen time in childhood has become a more pressing issue since the coronavirus pandemic. In many countries, including Singapore, schools and children's activity centres shuttered and stay-at-home orders were put in place.

Lockdown measures inevitably led to increases in children using screens at home to occupy their time or to access home-based learning. With restrictions in place for considerable time there is the likelihood that these changes in behaviours have been embedded.⁴

Aims

The Saw Swee Hock School of Public Health was asked by the Singapore Ministry of Health (MOH) to undertake a review of the evidence around screens use in childhood. The focus of the review was to identify:

- Trends in screen use in childhood.
- Impacts of screen use in childhood.
- International guidance related to screen use in childhood.
- Interventions that may be effective in reducing screen use in childhood.

The following report summarises the findings from a rapid research scan of the evidence base.

Research Approach

The project took a literature scan approach and was not a full-scale systematic review.

For the initial broad search the following word strings were used in June 2022 on PubMed and filtered for relevant systematic reviews: "screentime", "screen time", "screen use", "children". Targeted topic searches were also undertaken scanning and filtering for systematic reviews and reviews of reviews (eg including the above key words and the addition of "obesity" / "sleep" / "neurodevelopment" / "addiction" and so on).

There has been an exponential growth in the number of scientific publications related to sedentary behaviour and screen use in childhood.⁵ Studies focus predominantly on the potential negative impacts of screen time.

Given the proliferation of individual studies on screen use in childhood the review focused on systematic reviews and reviews of reviews. Greater prominence was given to the more recently published systematic reviews. Where particularly relevant reviews were identified the references were scanned to identify further systematic reviews. No historic limit was placed as a date cut-off on this initial scan.

A total of **97** relevant systematic reviews, meta-analyses and reviews of reviews were identified and included.

Many of the systematic reviews cited limitations. Key limitations included the following.^{6,1}

- Research predominantly focused on the negative effects of screens and took no account of potential benefits.
- Research was often limited by a lack of analysis regarding the “chicken and egg dilemma”, ie what came first? Was a potential negative impact predictive of more screen time, or was screen time predictive of negative outcomes (eg mental health concerns, obesity and so on)?
- There was a reliance on self-report data, small sample sizes and results that inferred correlation not causation.
- Evidence on the factors potentially mediating and/or moderating the relationship between screen use and poor outcomes was limited.
- Little analysis was available on population subsets (eg specific age bands, gender, baseline health and mental health status).
- Qualitative analysis was often lacking which would critically appraise evidence about experiences of different types of screen-based activities.
- Reanalysis of the same datasets often produced different results.
- Cross-sectional data studies lacked prospective research designs. This prevented reviews from providing a clear indication of the nature of any causal relationship between screen-based activities and outcomes.

Websites of relevant country specific organisations were also scanned for international guidance and the underpinning evidence behind recommendations.

The majority of articles that were included were in English. However, the Chinese guidance and news articles were translated through Google translate and checked by a Chinese speaker.

The Singapore MOH requested that the review explore evidence related to children under the age of 12 years and age bands within this group. Many of the relevant systematic reviews (and studies within them) did not focus solely on an age 12 cut-off (or indeed age bands within the 12 years and under group) and so the report outlines the findings across the continuum of childhood to age 18 years old.

Many of the systematic reviews did not define the type of screen or content. Earlier systematic reviews predominantly focus on television viewing. Better-quality research is required on newer media devices and different types of content and interactions with screen-based technologies.⁷

Key Terms

The following definitions are taken from reviews of the evidence and international expert consensus.

Screen time refers to the time duration spent on screen-based behaviours. These behaviours can be performed while being sedentary or physically active.⁸

Some researchers have recently argued that the assessment of screen time is meaningless unless measures describe what screen users are doing and why.² While newer measures assessing use of screens by children are being developed, the methods used to quantify screen time in young children in studies conducted over the last decade are rarely scrutinised.²

Given these issues, many researchers focus on sedentary behaviours, rather than the single focus of duration of screen time.

Sedentary behaviour refers to any waking behaviours with an energy expenditure of <1.5 metabolic equivalent units (METs) while in a sitting, reclining, or lying posture.⁸

Common sedentary behaviours include sitting in school or the workplace, screen use, sitting in transport, and reading while sitting. Time spent on sedentary behaviours can be self/parent-reported or be objectively monitored by wearable devices such as accelerometers.^{8,9}

Non-screen-based sedentary time refers to the time spent in sedentary behaviours that do not involve the use of screens. For example sitting at school, sitting doing homework or art work, reading a non-electronic book, playing a board game, sitting in a car.⁸

Sedentary screen time is time spent using a screen-based device while being sedentary in any context. It does not include active screen-based games where physical activity or movement is required.¹⁰

Active screen time is time spent using a screen-based device while not being stationary in any context. For example, playing active video games, or running on a treadmill while watching television.⁸

Physical activity is any physical movement or muscular exertion which increases energy expenditure; moderate to vigorous physical activity raises energy expenditure to at least three times an individual's basal metabolic rate.¹¹

Physical inactivity is doing no or very little physical activity at work, at home, for transport or in discretionary time.¹²

Recreational screen time is time spent in screen behaviours that are not related to school or work.⁸

Excessive screen use is sometimes defined as screen duration that is above recommended guidelines from national and international organisations.¹³ However, other

researchers define excessive screen use based on whether the use interferes with normal daily functions and is difficult to control.

There is disagreement around the formal classification of excessive screen use as a “disorder” with some experts preferring to avoid medical terminology and defining “problematic” or “excessive” use of screens.

Screen stacking refers to the activity of doing different and unrelated things at the same time using multiple devices with a screen, for example, browsing the Internet while watching television.¹⁴

Harmful online behaviours refer to negative online activities like cyberbullying and sexting.

Meaningful screen use refers to benefits of screen use such as in education and maintaining positive relationships with family and friends. Potential benefits of screen use are outlined in a later report section.

TRENDS

Screen Time

The following section explores the trends in screen use in Singapore and internationally.

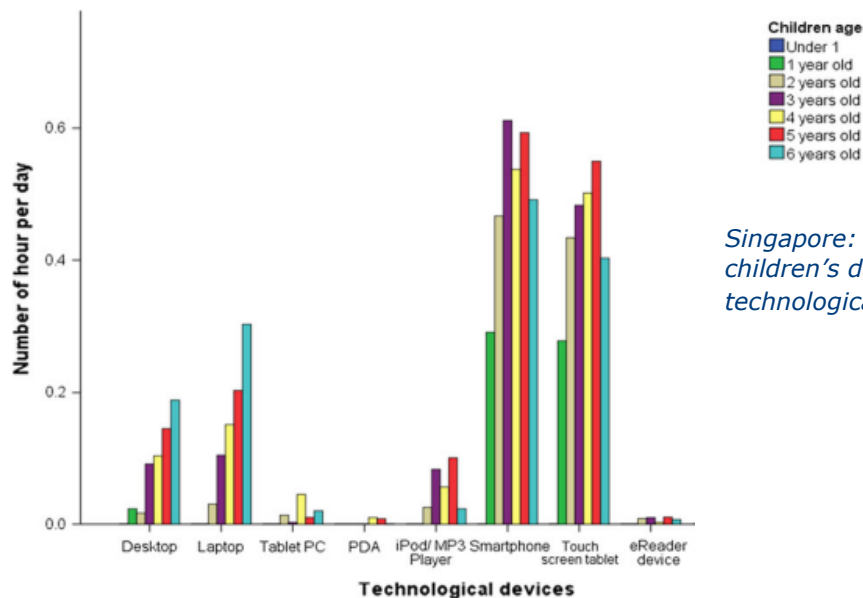
Sedentary behaviours (of which screen use is one) in childhood and adulthood have increased over the decades.^{15,16}

Studies in Singapore on screen time in childhood found high variation in the average amount of time children spend on screen each day. There is a clear association between increasing age and duration of screen use.¹⁷ Studies have reported the following average screen use durations for young children in Singapore.

- Age 1: 2 hours.¹⁸
- Age 2: 2.4 hours.¹⁹
- Age 3: 2.7 hours.¹⁹
- Boys: 2.4 hours.²⁰
- Girls: 2.3 hours.²⁰

A recent 2021 study reported that almost all infants and toddlers ages two and under are exposed to approximately 2 hours a day of screen time. Children as young as 6 months of age are now regularly being exposed to screens, often serving merely as pacifiers. By the age of 18 to 24 months, about 90% of children are engaged in daily passive viewing of screens (ie without co-viewing and interaction).²¹

In Singapore, Malay and Indian children have been found to spend more time on screens compared to Chinese children.¹⁹ Smartphones and touch screen tablets are the most frequently used screens in children aged under 7 years.²²



Singapore: Different age groups of children's daily time spent (hours) on technological devices (2016).²²

In Singapore a 2019 survey found that the average age children get their first Internet-connected device was 8 years old.²³

The average time children in Singapore spend on screen reflects international trends from other high-income countries.

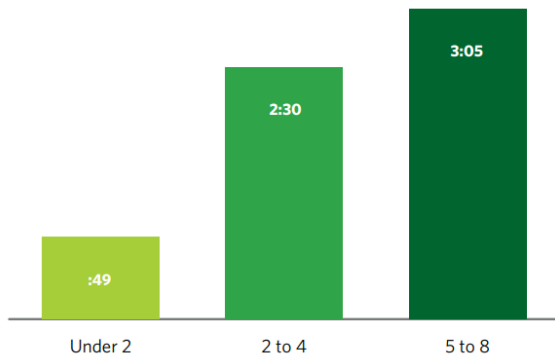
Over 90% of Taiwanese children aged between 3 and 5 use personal electronic devices at home, with 3 year olds averaging an overall screen time of 2 hours and 17 minutes a day.²⁴

A 2020 (pre-pandemic) large scale US survey found that on average, children from 0 to 8 years of age spend about 2 hours and 30 minutes on screens a day.²³

The US study found an increasing trend of children watching online videos and that as children age, there is less co-viewing with parents and that children are more likely to pick their own online videos to watch.²³ In the US, television hours among school-aged children have generally decreased in the past decade for children younger than 8 years. However, among children aged 8 years and older, average daily TV time remains over 2 hours per day.²⁵

A US survey found that in the US nearly half of 2- to 4-year-olds and more than two-thirds of 5- to 8-year-olds have their own tablet or smartphone.²⁶

2020 (pre-pandemic) US study children



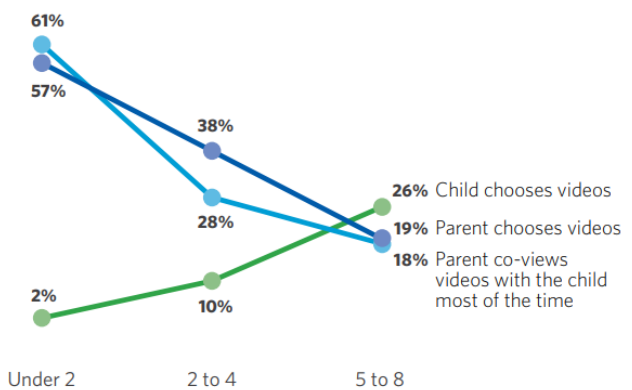
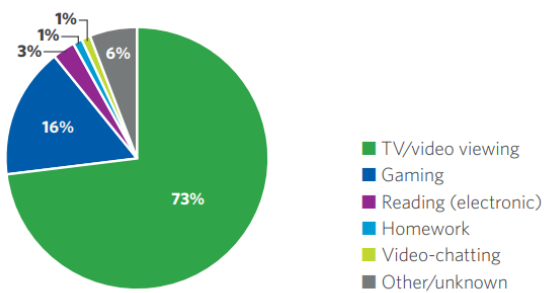
Screen use increases with age.

8 to 12 years average: 4:44 (hours:minutes)

13 – 17 average: 7:22

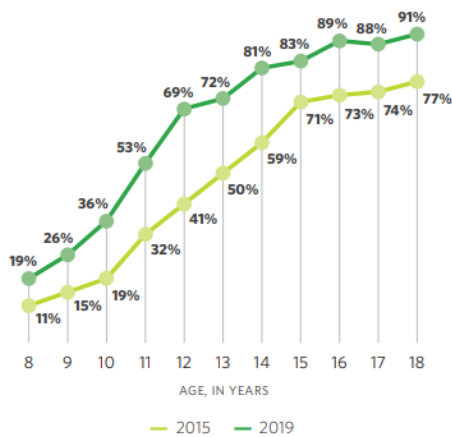
Not including time spent using screens for school or homework.²⁷

Average daily screen use among 0- to 8-year-olds (hours:minutes).⁴



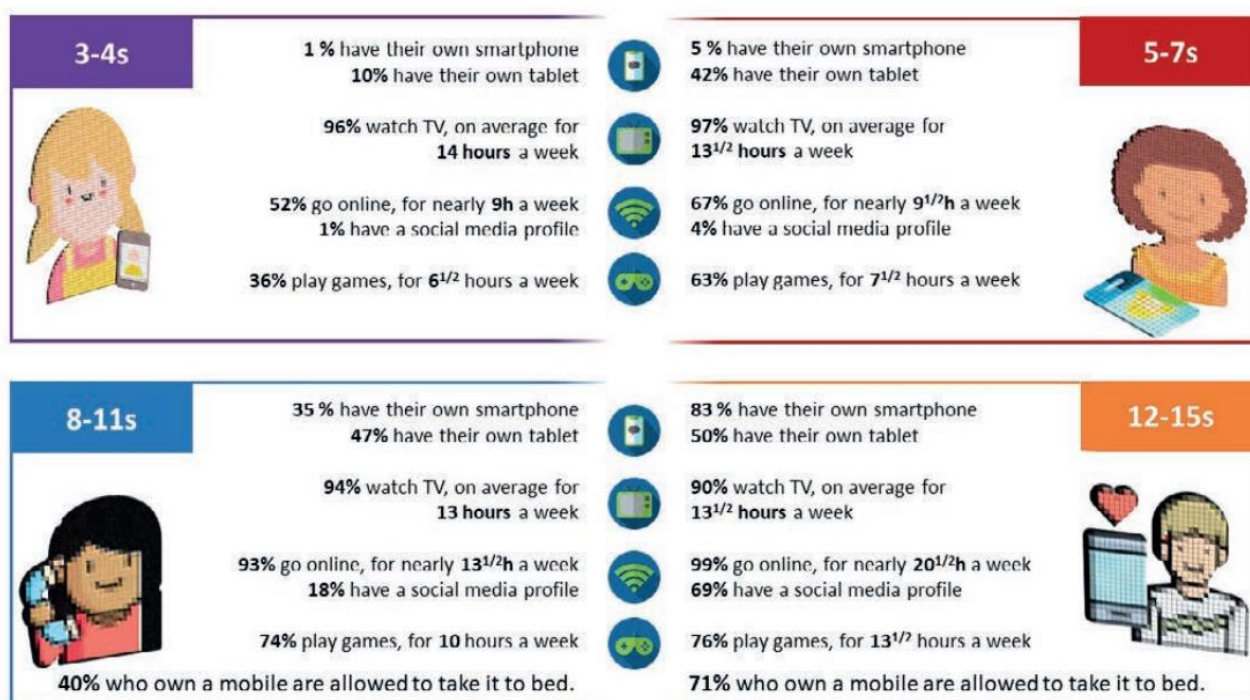
Types of screen use among 0- to 8-year-olds.⁴

Choosing / co-Viewing online videos, by Age, 2020.⁴



Smartphone ownership, by age, 2015 vs. 2019.²⁷

Children are using screens more and increasingly connected to the Internet at younger ages. In the United Kingdom, 52% of 3 to 4 year olds and 82% of 5 to 7 year olds go online.



Snapshot of children's media use in the UK (Ofcom, 2019).⁷

In China (pre-pandemic) it was reported that children spent around 10 hours a week on screens. of which, just under 3 hours was recreational. Given the rules in China around screen time for children the accuracy of self-reported screen time may be questionable (see later section on international guidance).²⁸

Influences

The influences on children's screen time and use are multi-faceted, with habits formed over time. The following factors are just some that have been associated with higher childhood screen use (pre-pandemic). These are in no particular order, as the relative influence of factors has not been robustly assessed.

Parental Factors	Child Factors
- Higher parental screen use.^{29,30,31,32,19,18} - Younger maternal age.^{30,19,18} - Poor maternal mental wellbeing.^{33,19,18} - Parental education level.²⁹ - Lower socio-economic group.²⁹ - Possible ethnicity influences.²⁹	- Screen use at early age.^{30,32} - Older age of the child.^{30,32} - Presence of a screen in the child's bedroom.^{30,34} - Possible gender differences (ie being a boy).³⁰ - Insufficient sleep. - Insufficient physical activity outside.

In Singapore, higher screen use in children has been found to be associated with younger maternal age, lower maternal education, suboptimal maternal mental health, and longer parental television time.^{19,18} Another Singapore study found that Chinese ethnicity,

younger maternal age and lower maternal sleep time were associated with greater screen use in children under 5 years in Singapore.³⁵

Pandemic

The pandemic, with stay-at-home orders and home-based learning for children has led to an increase in screen time internationally and in Singapore.³⁶

Pre-School Children

Internationally, pre-schooler screen time increased during the pandemic lockdowns. This was exacerbated in countries with longer lockdowns. From as young as eight months old, some had regular daily exposure to screens. Screen time increased with age, with older children reporting more screen time than younger children.³⁷

In a Singapore, children under 4 years old had less physical activity and sleep and spent more time on screens. Screen time in pre-schooler age increased by 23% a day, from 1 hour 45 minutes to 2 hours 9 minutes a day.¹⁷

School-Age Children

Lockdowns and school closures have led to higher screen time and lower physical activity among children and adolescents.^{38,37}

The following average daily increases in screen time were reported from data across multiple countries.³⁹ Primary school children experienced the highest increases in screen time.

- Under 5 years old: 36 minutes a day
- 6 to 10 years old: 1 hour 24 minutes a day
- 11-17 years old: 54 minutes a day
- Over 18 years old: 1 hour a day

Children (grouped as <18 years) increased their sedentary time by an average of around 2 hours and 45 minutes a day, although there was high variation from the average. Some children may have increased their overall sedentary time by more than five hours per day.⁴⁰

The variation in increases in sedentary time may be related to access to gardens and green spaces during lockdowns.⁴⁰

China has also reported lockdowns increased screen time of children and reductions in physical activity.²⁸

Total (n = 2426)	Before the pandemic	During the pandemic	Absolute change	P value ^a
Physical activity (min/week)	540	105	-435	<0.001
Inactive ^b	21.3%	65.6%	+44.3%	<0.001
Insufficient physical activity	18.8%	16.7%	-2.1%	
Sufficient physical activity	60.0%	17.7%	-42.3%	
Total screen time (min/week)	610	2340	+1730	<0.001
Leisure screen time (min/week)	170	450	+280	<0.001
Short (≤ 2 h/day)	92.7%	69.1%	-23.6%	<0.001
Long (> 2 h/day)	7.3%	30.9%	+23.6%	

Data are shown as median or percentages.

^aCalculated using Wilcoxon test or Chi-squared test.

^bDefined as < 30 min/day, whereas ≥ 30 and < 60 min/day for insufficient physical activity and ≥ 60 min/day for sufficient physical activity.

*Longitudinal study among children and adolescents (6–17 years) in China.*²⁸

Attitudes

There is limited research on parental attitudes to screen use in children and how these may have changed over time.

A 2020 survey of Singapore parents found that a high proportion of parents expressed concerns around screen use. Around 80% were concerned about screen addiction, poor sleep and access to inappropriate content. Just over 70% were worried about a lack of parent-child interaction. Just over 60% were concerned about eyesight and a lack of physical activity. Despite concerns, they did not lead to changes in parental actions to reduce screen time.²⁰

A 2016 survey of Singaporean parents found that 60% thought that touch screen devices may benefit children's intellectual development. Around 70% were concerned that screens could cause eye deterioration, 55% were concerned about screen addiction, and a substantial proportion were concerned about emotional and social impacts.²²

Developmental domains	Risks	Percent (%)
Physical	Vision deterioration	69.1
	Inactive lifestyle	9
	Radiation	5.1
Intellectual	Addiction	55.4
	Undesirable contents	13.6
	Over-dependence	8.8
Emotion	Poor social-emotional development	21.3
	Encouragement of instant gratification	
	Throw tantrums	18.7
Social	Impatience	17.3
	Poor social competence	27.1
	Social withdrawal	24.4
	Poor communication skills	8.8

The three most frequent developmental domain risks for children in using touch screen devices as identified by parents/caregivers in Singapore (2016).²²

In Canada, a survey found that three-quarters of parents were concerned about how much time children spend using screens.⁴¹ However, in the US a survey found 60% parents felt that their children spend “the right amount of time” on screens.²⁶

The US survey also reported that 75% of parents are satisfied with the amount and quality of the educational media available to their children. Nearly three quarters (72%) say the media their child uses help the child’s learning, and 60% say media help the child’s creativity. Most (59%) say they don’t find it difficult to get their child to stop using media when they ask, although 40% find it at least somewhat difficult. The only aspect of children’s media use that parents are clearly more negative than positive about is its effect on children’s physical activity, with 43% reporting that it has a negative effect.²⁶

Another US survey in 2020, found that among respondents who believe that parenting is harder today (two-thirds), 26% cite technology as the main reason. Many of these responses mention the increased use of technology and the rapid changes in technology that can be hard for parents to keep up with. They also mention how these technologies may be changing the behaviours and experiences of children. Parents cite concerns that they themselves are spending too much time on their phones and can be distracted by their phones when spending time with their children. There were also concerns raised around some parents over “sharenting,” (posting and sharing photos and other things about their children on social media). About half of social media-using parents (52%) say others share too much about their young children online. Only 18% of parents who use social media did not share things about their children on social media, citing privacy and consent issues.⁴²

POTENTIAL BENEFITS

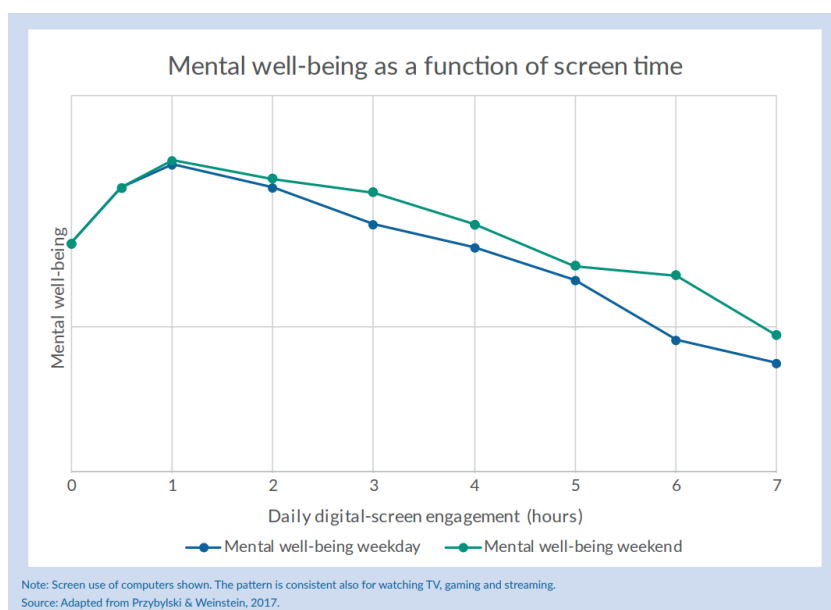
Family Connection

Screen based programs that are age-appropriate, co-viewed with family, and watched with purpose and limits, can be immersive, informative screen experiences and support emotional connections within the family.⁴³

Mental Wellbeing

Adolescents seem less susceptible to the negative effects of high screen time levels (eg over 6 hours per day) than younger children.

The impact of screen time on older children's mental well-being seems to be U-shaped. No-use and high-use can have a negative impact and moderate use (typically reported as between 2 and 4 hours per day) can have a positive impact. This is dubbed the "Goldilocks effect". The threshold varies and will depend on the individual screen activity and child.^{44,45,46,47}



*Goldilocks Effect of daily screen time engagement and mental well-being.*⁴⁵

Friendships

Digital technology can be beneficial for older children's social relationships.⁴⁴ It can help children make and maintain friendships, and these relationships may be more diverse and inclusive than those offline.⁴⁸ More introverted adolescents have been found to be strongly motivated to communicate online to compensate for lacking social skills, resulting in more online friendships.⁴⁹

Video gaming is increasingly social.⁵⁰ Many older children, especially boys, regularly socialise through games.⁵⁰ Some gaming has been positively associated with increased

sense of well-being, identify, prosocial behaviour, and fewer conduct problems (including studies from Singapore).^{46,51,52,46,53}

Cognitive Development

Gaming has been found to enhance specific perceptual and motor skills, including visual and spatial processing and hand–eye coordination.^{53,50,54,55}

Academic Performance

Educational television programs aimed at preschoolers can be effective in broadening young children's knowledge and increasing their imaginativeness.⁵⁶

Education games and apps can improve children's academic performance, enrich knowledge and literacy skills.^{25,57} Education games can result in cognitive gains and better engagement and attitude toward learning.⁵⁸

Adherence to Health Advice

Healthcare has become increasingly interested in “gamifying” medical interventions. A video-game intervention ('Re-Mission') significantly improved treatment adherence and indicators of cancer-related self-efficacy and knowledge in adolescents and young adults who were undergoing cancer therapy.⁵⁹

Social and Emotional Skill Development for Autism Spectrum Disorders

A review of computer-based interventions to improve social and emotional skills in individuals with autism spectrum disorders suggested some may have a positive impact.⁶⁰

POTENTIAL RISKS

Evidence is still in its infancy regarding screen type and content and much of the evidence to date has significant limitations (as outlined in the research approach section).

There are potential downsides to screen use, particularly in very young children. There appear to be associations between screen use and insufficient good quality sleep, sedentary behaviours, obesity, and mental health and well-being.

Many of the potential impacts associated with screens are interconnected and link directly to how a child spends the rest of their day.

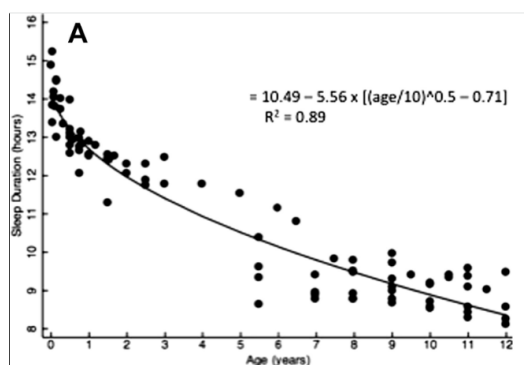
The inter-relatedness of sedentary behaviour (of which screen time is one), sleep and physical activity has led to several international guidelines taking a “healthy day” approach across the continuum of childhood (outlined in the international guidance section).

A whole day approach is often adopted due to the importance of ensuring balance across the day in terms of sedentary behaviours, sleep, and physical activity and recognition that increases in sedentary behaviours (eg screen time) can have a displacement effect on sleep and physical activity.¹

Sleep Behaviour

Getting adequate sleep is essential for health and wellbeing. The habits acquired in childhood often continue into adulthood. Globally, insufficient sleep is recognised as a public health epidemic that is often unrecognised, under-reported, and that has economic costs.⁶¹

Sleep behaviour refers to the duration and timing of sleep. For children under 5 years of age this includes both at night and daytime naps.¹⁰ Global norms in childhood sleep patterns are outlined below.⁶²

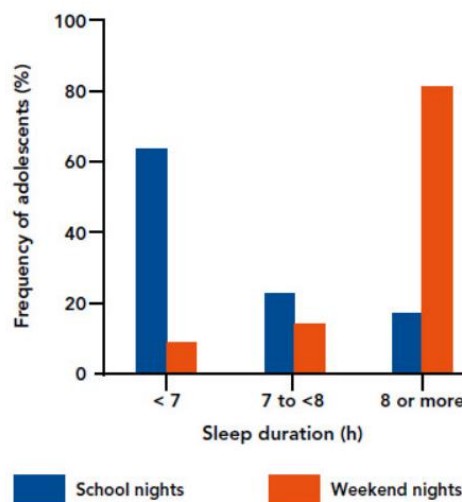


Scatterplots of sleep duration and age (0–12 years).

Sleep duration of predominantly Asian cultures is shorter over the 0 to 12 year age group (1 hour less across all ages). This difference is related to later bedtimes rather than daytime sleep and suggest a strong culturally based influence around night-time sleep behaviours. There is more night-time waking in Asian cultures within each age group, suggesting less good quality sleep in addition to shorter sleep overall.⁶²

Singaporean preschool children average 8 hours 30 minutes sleep a night and nap for around 1 hour 30 minutes in the day. This is less than the global average for this age. Co-sleeping is common, 80.9% of children share a room with someone else. The most common sleep problems are requiring company to fall asleep (73.1%), being afraid to sleep alone (61.6%) and difficulty in waking up (44.4%).⁶³ Most parents (84.1%) perceived that their child's sleep duration was adequate, suggesting a cultural norm to this type of sleep behaviour.

In Singapore, about 80% of adolescents have insufficient sleep on a weekday.⁶⁴ International guidelines have a consensus view that adolescents should get 8 to 10 hours of sleep a night for optimal health and cognitive functioning.



Sleep survey results of adolescents in Singapore (N=2214).⁶⁴

Most adolescents in Singapore extend their sleep duration by more than 2 hours on weekends, suggesting that they are not getting sufficient sleep on school nights. Weekend "catch-up sleep," even when combined with napping during weekdays, is inferior to receiving a 9 hour block of sleep each night when looking at neurobehavioral measures.⁶⁵

Screens and Sleep Behaviours

The increased use of screens is worsening the epidemic of insufficient sleep and poor quality sleep.⁶¹

Screen use may interfere with sleep onset and displace time spent sleeping. The psychological stimulation from screen content may also impact sleep behaviour.⁶⁶

Evening exposure to bright light from screens may disturb the sleep-wake cycle and suppresses the melatonin production. There has been some small scale research on the impact of screen and melatonin and the circadian system.⁶⁷ However, more robust research is needed to determine effects.

Across age groups, there is consistent evidence that screen use is associated with poor sleep behaviours:^{66,68}

- 0- to 5-year-olds: Screen use is associated with difficulties in falling asleep and less sleep duration. Heavier screen use is associated with increased daytime napping, which suggests poorer sleep consolidation and less mature sleep patterns.
- 6–15-year-olds: Screen use in general and at bedtime is associated with later bedtimes, shorter sleep duration, sleep disturbances and awakening at night. Screens in bedrooms amplify these negative impacts on sleep.

Previous systematic reviews reported similar findings on the impact of childhood screen use on sleep behaviours (later bedtimes, shortened duration, and night-waking).^{13,69,70,71,72,73}

Health Impacts of Insufficient Sleep

There are strong associations between insufficient sleep and negative health and wellbeing impacts.

- **Sedentary Behaviour:** Getting adequate sleep in childhood is associated with less sedentary time and a higher proportion of the daytime spent being physically active. Whereas, shorter or later sleep is associated with greater sedentary or screen time.^{74,75,76}
- **Mental Wellbeing:** In children aged 0 to 4 years, longer sleep duration is associated with emotional regulation.⁷³ In children aged 5-17 years, longer sleep duration is associated with better emotional regulation and better quality of life/well-being.⁷⁷

Adolescents with insufficient sleep are likely to suffer from depressive symptoms.⁶¹ Getting adequate sleep can have a buffering effect on the negative effects of screen use. The link between screen time and behaviour problems was moderated by sleep duration, as it was significant only for children with less than 9 hours and 52 minutes sleep a night. Sleep duration also moderated the relationship between screen time and anxiety.⁷⁸

- **Cognitive Performance:** Insufficient sleep is linked to cognitive impairment.⁶¹ In children aged 5-17 years, longer sleep duration is associated with better academic achievement.⁷⁷

In Singapore, insufficient sleep in adolescence has been found to impair a wide range of cognitive functions, subjective alertness, and mood (even in high-performing adolescents).^{79,80} In adolescents, good sleep habits (and good study habits ie not cramming the night before, but spacing out learning) can optimise exam outcomes.⁸¹

- **Obesity:** Sleep duration seems to influence weight gain in children, however, the underlying explanatory mechanisms are still uncertain.⁸² In children across all ages, longer sleep duration is associated with lower levels of obesity and insufficient sleep associated with being overweight and obese.^{73,77,61}

In Singapore, the odds of being overweight are about 2-fold higher in adolescents with insufficient sleep (less than 7 hours on school nights) compared with those who sleep for between 8 - 10 hours a night.⁶⁴

- **Accidents:** Insufficient sleep is linked to increased accidents.⁶¹ In children aged 0 to 4 years, less sleep is associated with increasing prevalence of injuries.⁷³
- **Chronic Disease:** Insufficient sleep is linked to higher risk of chronic conditions.⁶¹ It takes time for chronic conditions to appear and so there is limited evidence of sleep associations with chronic conditions in childhood.

In Singapore insufficient sleep has been linked to biological ageing and cardiovascular disease risk in adults.⁸³ A study found 44% of adults have insufficient sleep on weekdays (they had less than 7 hours sleep). These individuals tended to use mobile devices in bed or in the bedroom, smoke, and have caffeinated drinks two hours before turning in.⁸⁴

Sedentary Behaviours

Sedentary behaviours (of which screen use is one) in childhood and adulthood have increased over the decades.^{15,16} The increase in sedentary behaviour is a public health concern as less time is spent being physically active or sleeping.¹¹

Sedentary behaviour varies across countries but does consistently increase with age. There is a clear increasing trend of sedentary behaviours as children age.⁸⁵ On average children spend 20 minutes more sedentary with each passing year.⁸⁶

By adulthood physically inactive adults are at higher risk of all-cause mortality, developing chronic diseases, lower quality of life and poorer cognitive functioning.⁸⁷ In adults, for all-cause mortality, a threshold of 6 to 8 hours a day of total sedentary behaviour and 3 to 4 hours a day of television viewing (eg recreational screen use) was identified, above which the risk is increased.⁸⁸

For children age 0-4 years old there is often no association identified between sedentary time and obesity, however obesity takes time to manifest and studies can lack a long enough follow up to reveal an association.⁸⁹

There is a consistent association between high levels of sedentary behaviour (particularly screen time) and being overweight/obese among school aged children and adolescents.^{13,76,90,91,92,93,94,95,96} This association was replicated in studies of Asian school children.⁹⁷ The impact of screen time on obesity links is outlined in the next section.

Obesity

Childhood obesity is associated with a higher chance of obesity, premature death and disability in adulthood. Obese children also experience breathing difficulties, increased risk of fractures, hypertension, early markers of cardiovascular disease, insulin resistance and psychological effects.⁹⁸

Obesity is largely preventable through limiting energy intake and engaging in regular physical activity.⁹⁸

For children aged 0 to 18 years old there is moderately strong evidence for associations between screen time and greater obesity and moderate evidence for an association between screen time and higher energy intake, poor diet quality, lower fitness, and poorer quality of life. There is weak evidence for associations of screen time with metabolic syndrome or poorer cardiorespiratory fitness.^{99,90,100,101}

Screen time, even in the absence of food advertising, has been found to be associated with increased dietary intake compared with non-screen behaviours. Suggested explanations for this relationship included: distraction, interruption of physiologic food regulation, screen time as a conditioned cue to eat, disruption of memory formation, and the effects of the stress-induced reward system.¹⁰²

Mental Health and Well-Being

Excessive screen time has been associated with depressive symptoms in children and adolescents.^{99,6} The type of screen influences the strength of the screen-based depressive symptoms relationship. Television viewing appears less likely to be associated with depressive symptoms, compared to computer use and videogame playing. Less consistent evidence was available on gender differences.¹⁰³

There is weaker evidence for associations between screen time and behaviour problems in children and adolescents. Namely, anxiety, hyperactivity and inattention, poorer self-esteem, poorer well-being and poorer psychosocial health, and poorer cognitive development. No or insufficient evidence was found for an association of screen time with eating disorders or suicidal ideation.⁹⁹

Excessive screen time was associated with negative behavioural, and psychosocial behaviours in toddlers and preschoolers.¹³ Similarly, limiting sedentary screen-based activities is associated with psychosocial benefits for children aged 0-4 years.⁸⁹

In younger children screens can be disruptive to play, reduces the quality and quantity of child-parent interactions, and is associated with inattentive/hyperactive behaviours, lower executive functions, and language delay, at least in the short-term.⁹⁹

Children and adolescents who spend most of their time on screens are at greater risk for aggressive behaviours. However the type of screen content that the studies looked at varied.^{104,90} Video games of a violent nature have not been found to be associated with higher aggression.⁵⁵

Addiction

There have been concerns about gaming and addiction expressed by policy makers, the media, parents and teachers. "Internet Gaming Disorder" (IGD) has been included in the Appendix of the Diagnostic and Statistical Manual of Mental Disorders-V (DSM-V) and as "Gaming Disorder" in the draft of the 11th revision of the World Health Organization's International Classification of Diseases (ICD-11).¹⁰⁵ There is a consensus that IGD presents across three core areas: (1) withdrawal, (2) loss of control, and (3) conflict.¹⁰⁶ . Proposed symptoms include unsuccessful attempts to quit gaming, giving up other activities, continuing to game despite problems, deceiving family members or others

about the amount of time spent on gaming and using gaming to relieve negative moods.¹⁰⁷

Gaming may be associated to brain reward pathways (generally associated with substance addiction) being implicated in gaming.¹⁰⁸ However, there are methodological concerns regarding studies on this topic and further research is needed.

Some experts prefer to avoid medical terminology and define "problematic" or "excessive" use of technology based on whether the use interferes with normal daily functions and is difficult to control.

There is concern that the inclusion of Internet Gaming Disorder as a diagnosis will cause significant stigma to the millions of children who play video games as a part of a normal, healthy life. There are also concerns around the low quality of the research base, linking too heavily to substance use and gambling criteria, and the lack of consensus on symptomatology and assessment of problematic gaming.¹⁰⁹

Some studies in children have suggested concerning rates of IGD in children; however symptomatology and assessment was not robust and methods varied.^{7,110} Some studies suggest an association between IGD and Attention Deficit/Hyperactivity Disorder (ADHD), although further research is needed to understand what came first, the ADHD or IGD.¹¹¹ Longitudinal studies controlling for baseline mental health are needed.

More robust analysis of adults suggests that around 0.3 to 1% percent of the general population might qualify for a potential diagnosis of IGD. There is an important distinction between someone enthusiastic and focused on gaming and someone with an illness/addiction. The authors of the analysis concluded that "video game addiction might be a real thing, but it is not the epidemic that some have made it out to be." (Dr Patrick Markey, Dr Christopher Ferguson).¹⁰⁵

To note, there has been debate around the boundaries between normal and abnormal (or excessive and pathological) screen use. Defining boundaries is challenging as behavioural patterns and the extent of use vary widely between individuals and cultures. Generational effects and social norms are also relevant in defining boundaries with normality for rapidly developing technologies.¹¹²

Online Vulnerability

Studies report psychological and psychiatric problems (eg depression, anxiety, eating, and neurodevelopmental disorders) are sometimes associated with problematic usage of social media, more so in children with pre-existing mental health conditions. This is often correlational research and more research integrating biological and environmental factors is required to fully elucidate the development of disorders.^{113,114,115}

Cyberbullying and traditional bullying overlap, although online bullying presents unique challenges. These challenges include perpetrator anonymity and bullying at any time of day, rapidity of information spreading online, and that perpetrator and target roles can be quite fluid in the online world. Cyberbullying can lead to negative social, academic, and health consequences for both the perpetrator and victims as well as increased risk of self-harm and suicide ideation.^{116,117}

A 2015 UK survey found that 4% of all 12-15s and 1% of all 8-11s say they were bullied on social media. Other surveys have found higher levels of one in five of online 7 to 16 year old's saying they have been bullied online.¹¹⁸

"Sexting" is commonly defined as the electronic transmission of nude or seminude images as well as sexually explicit text messages. In the US it was estimated that around 12% of children aged 10 to 19 years have ever sent a sexual photo to someone else.¹¹⁹ The Internet also has created opportunities for the exploitation of children by sex offenders through social networking, chat rooms, e-mail, and online games.¹²⁰

A 2014 UK study found that 12% of online 9-16s have seen sexual images online. The same proportion of online 11-16s (12%) said they'd seen websites where people talk about taking drugs, and 17% had seen sites where people discuss ways of physically hurting themselves. 4% said they'd seen websites where people discuss ways of committing suicide, and the same proportion (4%) said they had received "sexting" messages.¹¹⁸

These percentages represent sizeable numbers of children. In an average class size of 30 children, it means that: approximately three children have seen online sexual images; five children have encountered sites about physical harm; and one child has received sexting messages.

Cognitive Development

Cognitive development is the process of learning, memory, attention, concentration and language development.¹⁰ Executive function is a set of mental skills that include working memory, flexible thinking, and self-control.¹²¹

The impact of screen time on neurological development in very young children is a growing field of research. There are studies that suggest a negative of screen use on the impact on brain development in very young children.²¹ A recent small-scale Singapore study has also suggested that infant screen use may be an upstream environmental factor contributing to individual differences in the development of the frontoparietal brain regions and later executive functions critical for academic performance. However, replication of this study's findings and randomised controlled trials are required.¹²²

Systematic reviews confirm the negatives of screen use may outweigh any positives in children under 5 years old (see sections on language development and attention below).¹²³ The negatives tend to increase with increased time spent on screens. There is also a strong distraction factor associated that may limit under 5's participation in other types of activities and more high-quality face to face interactions (research was on touch screens).¹²⁴ Further research is required.

In older children there is weak evidence for associations of screen time with poorer cognitive development.^{99,121}

Language Development

High quality content focused on learning and co-viewing can positively influence language development.¹²⁵

However, for children under 2 years the negatives of screen use seem to outweigh the positives in terms of language development. Later age of screen use onset is also associated with stronger child language skills.¹²⁵ There is also a negative association between the duration of screen use and lower language skills in young children.¹²⁶

Academic Performance

There is weak evidence for associations of screen time with lower educational attainments in the under 18 age group.⁹⁹ Individual types of screens may have a different association. Television viewing and video game playing appeared to be the activities most negatively associated with academic outcomes, but further research is required.¹²⁷

To note, 'screen stacking' (using multiple screens at the same time) may be linked to lower academic scores, weaker working memory, lower sustained attention, and greater impulsivity in adolescents.⁴⁶ Again, more research is required to determine effects.

Attention

In cohorts of children under 18 years old there is weak evidence for associations of screen time with inattention.⁹⁹

In younger ages excessive screen time in children could be associated with attention problems (0 to 12 year olds). For the 0 to 5 year old group screen time has been found to be predictive of the attention problems later on in childhood.¹²⁸ More research is required to address limitations (outlined earlier).

Myopia

Evidence for screen use and myopia are mixed. Studies are highly heterogenous in their measures of screen time and myopia-related outcomes which prevents effective analysis of the issue, and studies often fail to adjust for confounders.¹²⁹

Longer smartphone use may increase the likelihood of ocular symptoms, including myopia, eye strain, and dry eye, especially in children.^{130,131} However, further studies with objective screen time measurements are necessary to assess evidence of an association between screen time and myopia.

Cancers

Long-term mobile phone (longer than 10 years) use may be associated with an increased risk of brain cancer. There was also an association between mobile phone use and low-grade glioma in the regular use or long-term use subgroups. However, current evidence is of poor quality and limited quantity.^{132,133}

Children with Neurodevelopment Issues

Children and adolescents with autism are typically exposed to more screen time than their non-autistic peers and the exposure starts at a younger age. Long-term consequences of early screen exposure in autistic children (before the age of 3 years) remain largely unexamined.¹³⁴

A Singapore study of preschool children with neurodevelopmental disorders found that more than half (52%) were exposed to screens / commenced screen usage at the age of 18 months or earlier. More than half (57.7%) had at least one screen device in their bedrooms. The majority (93.9%) used screens for more than an hour a day. The average daily child screen time was 3.79 hours. Increased screen use in preschool children was associated with parents who have higher screen use themselves, and who are less likely to have house rules about screen use. Elevated issues around behaviours and sleep were found.^{135,136} However, the issue of “chicken and egg” study limitation likely applies in this context, ie what came first, the higher screen use or the behaviour issues?

SUMMARY OF INTERNATIONAL GUIDANCE

This section should be read alongside Appendix A which has the expanded versions of international guidance.

The WHO, American, Canadian, Australian, New Zealand, German, Asia-Pacific and Singaporean, adopt time-limit approaches to screen time by age. These guidelines often cite the same systematic reviews, which were undertaken for the Canadian guidelines around 2016. However, the evidence does not point to a specific time limit approach by age bands; these seem to have emerged based on consensus viewpoints of committees tasked with developing guidelines.

Time based guidelines have been criticised as not being fully evidence-based and being focused on risks, rather than recognising the world in which children are now living within and the potential benefits of digital screen use in education and industry.^{137,138}

Time based guidelines generally recommend:

- No screen time at all for children under 2 years old.
- No more than 1 hours a day for pre-schoolers.
- No more than 2 hours a day for school aged children and adolescents.

There are commonalities across international guidance around switching off screens an hour before bed and having times (while having dinner as a family) and locations (the bedroom) that are designated media-free. These do appear to be more grounded in evidence around the impact on social interaction and sleep, respectively.

Taiwan and China have stricter rules on screen time limits with legal implications for non-compliance.

Taiwan states that under 2's should not use screens, 3 year olds be limited to 30 minutes of screen time per day, and that 4 to 6 year olds be limited to one hour, with a 10-minute break every half hour to rest their eyes.

China states that children should be limited to just three hours of online game playing a week (one hour between 8pm - 9pm on Friday, Saturday and Sunday).

United Kingdom guidance has only one primary recommendation, that families should negotiate screen time limits with their children based upon the needs of an individual child, the ways in which screens are used and the degree to which use of screens appears to displace (or not) physical and social activities and sleep. This recommendation was made based on a review of the evidence and determination that setting specific time-limits was based on weak evidence.

Most guidance (except China and Taiwan) recognises screen time as only one component of sedentary behaviour and takes a holistic approach to the **whole 24 hour period** and the balance of **sleep, physical activity, and sedentary behaviour** across the day, making "the whole day matter". Guidance also recognises the need to develop age specific strategies from early childhood through to adulthood.¹³⁹ This is reflected in the Singapore guidance for children ages 7 to 18 years and Asia-Pacific 24 hour integrated guidance.

Singapore College of Paediatrics & Child Health and Academy of Medicine

Integrated 24 hour activity guidelines for children aged 7 to 18 years

The Singapore College of Paediatrics & Child Health and Academy of Medicine published integrated 24 hour activity guidelines for children aged 7 to 18 years in 2021 (outlined in Appendix A).¹⁴⁰ The guidance aims to encourage Singaporean children and adolescents to adopt a holistic approach towards integrating all types of activity within a daily 24-hour period.

The guidance states that these activities (including light, moderate and vigorous physical activity, sedentary behaviour, sleep and eating activity) are closely inter-related in terms of health benefits and time consumption.

The guidance also states that it is equally vital to understand the importance of each type of activity and to organise these activities throughout a day (and night) schedule for the best health outcomes.

In terms of recreational screen use, the guidance signposts to international recommendations on less than 2 hours a day for this age group.

When children meet guidelines that span across sleep, physical activity, and sedentary behaviours they have been found to have improved health and mental wellbeing.¹⁴¹

Children with a combination of high physical activity/high sleep duration/low sedentary behaviour had more desirable measures of adiposity and cardiometabolic health compared with those with a combination of low physical activity/low sleep duration/high sedentary behaviour. Of the three behaviours, physical activity (especially moderate- to vigorous-intensity) was most consistently associated with desirable health indicators. However, given the lack of randomised trials, the overall quality of the available evidence was low.¹⁴²

Across all countries and international organisations there is information and resources available on how to keep children safe online. These generally cover education and awareness, parental controls, privacy, and blocking and reporting.¹¹⁸

Meeting Guidelines

Most children, across all ages and multiple countries, don't meet recommendations within 24 hour movement guidelines or screen time guidelines.^{143,144,34,145,139} Consistently around two-thirds don't meet guidelines.

Children from high-income countries more likely to exceed screen time guidelines compared with those from lower-income and developing countries.¹⁴⁶

A Singapore survey reported on the proportion of children under 5 years old meeting the 24-h **WHO guidelines** of (i) having at least 180 minutes of physical activity (ii) engaging in less than 60 minutes of screen media and (iii) having 10–13 hours of good quality sleep a day.

Only 9.6% of children under 5 years met all the WHO guidelines and only 27% met screen guidelines.¹⁴⁷

24-h World Health Organisation guidelines	Met		Did not meet	
	Valid %	N	Valid %	N
180 min of physical activity	56.9	1282	43.1	973
10–13 h of sleep (including naps)	70.7	1602	29.3	663
Screen media time of 60 min or less	26.5	621	73.5	1725
All of the above guidelines	9.6	228	90.4	2156
Valid %			N	
Parent-reported number of guidelines met by preschool children				
None	12.6	300		
1	37.3	891		
2	40.5	965		
3	9.6	228		

*% of children under 5 years meeting WHO guidelines (2019).*¹⁴⁷

Another Singapore study reported on the proportion of children under 5 years old meeting the **24 Hour Canadian and Australian Movement Guidelines** of (i) ≥ 60 minutes of moderate-to-vigorous physical activity a day (ii) ≤ 2 hours of screen time/day (iii) having 9–11 hours of sleep a day.

Only 5.5% of children aged 5.5 years met all the guidelines and 11.2% of the children met none of the movement guidelines. Although there is high variation, a substantial proportion of children did not meet individual guidelines, particularly night-time sleep guidelines (likely due to the tradition of napping in the preschool routine).³⁵ Parent role modelling was associated with meeting some of the guidelines.

	Mean $\pm$ SD	Median (IQR)
Screen viewing (total)	101.9 $\pm$ 88.7	77.1 (42.1–140.7)
Television	49.4 $\pm$ 49.4	37.1 (9.3–64.3)
Computer	12.6 $\pm$ 28.5	0.0 (0.0–17.1)
Mobile devices	34.8 $\pm$ 47.3	17.1 (0.0–51.4)
Game consoles	3.6 $\pm$ 14.7	0.0 (0.0–0.0)
Physical activity (total)	431.9 $\pm$ 67.3	437.9 (388.9–477.4)
Light intensity	364.6 $\pm$ 57.0	371.3 (324.6–401.0)
Moderate-to-vigorous intensity	67.3 $\pm$ 23.7	64.8 (49.8–81.6)
Sleep duration (total)	538.8 $\pm$ 58.1	542.0 (501.3–578.8)
Night-time sleep	480.6 $\pm$ 57.2	483.6 (442.2–524.0)
Daytime sleep	58.3 $\pm$ 29.2	56.0 (37.3–74.7)

Abbreviation: SD (standard deviation); IQR interquartile range)

*Daily time (min/day) spent in self-reported screen viewing and accelerometer-measured physical activity and sleep at age 5.5 years in the GUSTO cohort (N = 547) (2019).*³⁵

In 2020, only a small proportion of children in Singapore met the WHO recommendation of one hour per day or less screen time for children under 4 years. By age 2 to 3 years children in Singapore spend an average of 2.5 hours a day on screens. Children who were higher users of screens at a younger age went on to be higher users throughout childhood. Higher users of screens had lower levels of physical activity a day.^{148,149}

INTERVENTIONS

Interventions focused on screen time often only reduce duration of time spent on screens by a relatively small amount of time (eg less than 30 minutes a day).^{31,150} Very few studies look at the type of screen or screen content.

Small changes could be important in terms of displacement to other activities. Reducing screen time (sedentary behaviour), could lead to increased reading, social interaction, physical activity or sleep. These could then lead to benefits to childhood development.^{151,89,152}

Research is in its infancy. More effective interventions may include a focus on the following aspects.

- Early Childhood: Develop positive habits as early as possible in childhood.
- Parental Involvement: Develop parental capability and confidence to set goals with children, provide motivation for children to make habit changes (eg 'earned screen time') and be good role-models (eg for screen use, sleep behaviours and physical activity).
- Whole Day: Interventions should a holistic approach and incorporate advice and guidance on sedentary behaviour (of which screen time is just one), sleep behaviour, and physical activity, as well as guidance on diet.
- Public Health Programmes: Addressing behavioural change in children and adolescents is most effective when used as a comprehensive and multifaceted strategy rather than a singular-component intervention.

Early Childhood

Targeting sedentary behaviour interventions at a young age are likely to have the greatest impact.^{153,154} As children progress through childhood they spend more time sedentary, making the establishment of early healthy behaviours ever more important.¹⁵⁵

As outlined in the risk section, the potential negative impacts of screen use seem to be more pronounced in early childhood.

Healthy behaviours established in early childhood are more likely to be carried on into later childhood and adulthood. A Singapore study of children aged 5 to 8 years old found that those with early healthy habits were more likely to carry them through to follow-up, supporting the importance of establishing good habits early on in childhood.¹⁵⁶

Parental Involvement

A key recommendation from a Cochrane Review on reducing childhood obesity was "parent support and home activities that encourage children to be more active, eat more nutritious foods and spend less time in screen based activities".¹⁵⁷

Family-based sedentary time interventions with high parental involvement are more likely to lead to behaviour changes in children.^{158,153} Similarly, higher screen use in children aged 0 to 5 years is associated with a lack of parental focus to reduce screen time.³¹

Parent interventions have been found to reduce childhood screen use. Effective interventions may include: motivating and encouraging alternative sedentary behaviours that are interactive (eg reading aloud, drawing, doing jigsaws and so on); role modelling behaviour; setting goals; mediating and monitoring screen use and content; co-viewing; and earning screen time.^{7,31,159,160,161}

It was not possible to determine which parenting interventions should be targeted due to the variability of studies as well as cultural differences. For example the definition of parental mediation and monitoring of screen use is variable – some cultures emphasise children's personal choices and they may provide advice, whereas others emphasise parental authority and restrictive mediation, and more readily supervise their children's behaviour.¹⁶²

The role of the family is essential in establishing healthy behaviours in childhood. Family cohesion can have a protective effect on screen use.¹⁶² Similarly, a lack of family cohesion and family conflict are consistently linked to problem screen use in adolescents. In this case, problem screen use was defined as screens taking precedence over other life interests and daily activities, and an inability to stop or de-escalate screen use despite experiencing negative consequences.

Whole Day

Interventions should seek to incorporate advice and guidance on sedentary behaviour (of which screen time is just one), sleep behaviour, and physical activity, as well as guidance on diet. In addition, consideration of social emotional aspects of childhood (eg ensuring quality interactions / conversations).

Guidance should seek to recognise and build on the inter-connections of movement and diet through a child's day.

Given the expanded approach to interventions to covering the whole 24 hour period, the following section provides only the top-line findings of systematic reviews for each of the components of the day.

Sedentary Behaviour

Sedentary behaviour interventions in childhood could be effective in reducing screen time in children and adolescents. If there is an effect, it seems to be small. However, small changes can be important as children are then doing something else that may support good health (eg sleeping, physical activity).^{163,164,165}

Overall the evidence is variable, mainly due to a lack of high-quality studies and inconsistent findings. Further research is needed around children's motives to engage in sedentary behaviour, as well as their opinion on potentially effective intervention strategies.¹⁶⁶

Physical Activity

In the first years of a child's life, the home setting provides the most important impetus for physical activity. Parents play a central role in ensuring children are physically active through role modelling and providing opportunities.¹⁶⁷

In childcare and school settings, having an appropriate environment for physical activity and staff well trained in physical activity promotion can encourage increased levels. Regular structured exercise sessions can increase the scope and intensity of physical activity but should not replace free time for physical activity.¹⁶⁷

Outdoor time has been positively related to physical activity and negatively related to sedentary behaviour in children. The consistent positive relationship between outdoor time and physical activity held across sexes, age groups and contexts.¹⁶⁸

Outdoor activities do not tend to increase when children under 6 years old are given more time. They are most active in the first quarter of an hour. Consequently, providing more periods spent outdoors can be more effective in increasing levels of physical activity rather than extending the individual periods.¹⁶⁷

In schools, increasing the amount of time spent on physical activity and more physical activity offerings outside of class (eg breaks for exercise) can increase physical activity levels. As can improving the quality of the physical activity offerings and developing the skills of the staff used to promote physical activity.¹⁶⁷

In addition, it has been found to be important to: (1) integrate the promotion of physical activity (better) in school curricula, (2) create a school environment conducive to physical activity (eg by means of possibilities for physical activity using infrastructure, equipment), (3) involve parents in promoting the physical activity of their children and (4) promote active transport for getting children to school (in combination with the involvement of the parents and community).¹⁶⁷

Sleep

Promoting healthy sleep duration from an early age is an important driver for good health and wellbeing. Effective practices may include encouraging an earlier bedtime, limiting screen time, and establishing a regular bedtime routine.⁶⁹

The issue of school start times should be noted within the context of Singapore. Later school start times increases weeknight sleep duration among adolescents by delaying waking times. Increase in sleep duration occurs, even with relatively small delays in school start times of half an hour or so.¹⁶⁹

In Singapore school starts early, at 7:30. One secondary school, Nanyang Girls' High school changed their start time to 8:30 with the aim of increasing sleep duration of students.¹⁷⁰ After the change in school start time, adolescents reported longer sleep duration and fewer depressive symptoms.⁶⁴

Singapore's Ministry of Education has stated it is undertaking research on the impact of factors affecting sleep duration and sleep quality of students to better understand how later school start time could contribute to students' longer sleep duration.¹⁷¹

Diet

Family and school nutrition programs can improve dietary intake in children; however, evidence of the long-term sustainability of these impacts is limited.¹⁷²

Family-based programs which provided simple positive dietary advice to parents and regular follow-up reduced fat intake.¹⁷²

School and family-based studies, if designed and implemented well, increased fruit and vegetable intake, particularly fruit. Effective school-based programs have incorporated role-models including peers, teachers and heroic figures, rewards and increased access to healthy foods.¹⁷²

The modest overall impact of even these successful programs suggest complementary nutrition interventions are needed to build a supportive environment for healthy eating generally.¹⁷²

Reducing screen use may have an important role in preventing obesity and in lowering BMI in young children, and these changes may be related more to changes in energy intake than to changes in physical activity.¹⁷³

Social - emotional

Responsive caregiving supports infants in beginning to regulate their emotions and to develop a sense of predictability, safety, and responsiveness in their social environments. Nurturing, stable and consistent relationships are the key to healthy growth, development and learning.

High-quality relationships and interactions increase the likelihood of positive outcomes for young children. Children who are socially and emotionally competent have increased socialisation opportunities with peers, develop more friends, have better relationships with their parents and teachers, and enjoy more academic and social successes.¹⁷⁴

Intervention programs that target social-emotional development in preschool are ideally situated to bolster these skills before the problems exacerbate.¹⁷⁴

Public Health Programmes

Addressing behavioural change in children and adolescents are most effective when used as a comprehensive and multifaceted strategy rather than a singular-component intervention.¹⁶⁴

Many of the interventions and research focuses on school-based approaches. These alone may not be enough to counteract the trend of increasing screen time and sedentary behaviour.^{160,164}

Intervention to reduce children's screen time maybe effective if they included 'Goals, Feedback, and Planning behavioural techniques' and are delivered face-to-face in smaller groups and over several months (to enable follow-up).^{175,152,176}

Contrary to restricting screen-time, video games have been explored as potential tools to promote healthy behaviours in children, either using the games to teach or reinforce healthy eating strategies or to engage the player in physical activity. There is limited and ambiguous evidence on the effectiveness of these approaches.^{177,178,179,180}

CONCLUSION

Screens are ubiquitous in today's world and screen use is likely to increase further given current trends. It is important to understand the positive and negative impacts associated with their use in childhood.

Screen-based technology can be a benefit to children, such as supporting learning and communication to family and friends. However, too much time sitting down or using mobile devices can displace healthy activities, like sports and getting enough sleep.

Governments, media, parents, and public health researchers have previously emphasised negative impacts of screen use in childhood. Whilst there are negative impacts, the research to date has been skewed towards looking for negative impacts and study designs often have significant limitations. For example, many of the studies focus too much on the device itself and fail to take into account the type of content being delivered, and how it's being delivered.

The negative impacts identified are often interconnected to how a child spends the rest of their day, as screen time can displace other activities. The inter-relatedness of sedentary behaviour (of which screen time is one), sleep and physical activity suggests that a positive approach would be to take a holistic "healthy day" approach.

Some countries have adopted a cautious approach around screens, stating specific time limits on screen use per day, by age. The vast majority of children don't meet specific time limit guidance, suggesting this is an unhelpful strategy.

A more productive and positive approach may be to provide guidance on how a child should spend the whole day – to adopt a holistic approach to a healthy 24-hours which includes all sedentary behaviours (not just screen time), sleep, physical activity, diet, and social – emotional development.

Excessive time spent in various sedentary behaviours can coexist in a lifestyle that includes sufficient levels of physical activity. Healthy lifestyles should include being both physically active and limiting sedentary behaviours (especially screen time).

Alongside this could be an emphasis on healthy screen use hints and tips, such as not having screens at family mealtimes, not using screens before bed and not having screens in the bedrooms.

APPENDIX A INTERNATIONAL GUIDANCE

Guidance from international organisations and individual countries is outlined below.

Guidance on individual settings was out of scope of the review (eg childcare and education) although the broad guidance would span these settings.

Singapore

The Singapore College of Paediatrics and Child Health and Academy of Medicine have made a consensus statement in 2021 on 24 hour activity guidelines for children aged 7 to 18 years.¹⁴⁰

The guidance aims to encourage Singaporean children and adolescents to adopt a holistic approach towards integrating all types of activity within a daily 24-hour period.

The guidance states that these activities (including light, moderate and vigorous physical activity, sedentary behaviour, sleep and eating activity) are closely inter-related in terms of health benefits and time consumption. And that it is equally vital to understand the importance of each type of activity and to organise these activities throughout a day (and night) schedule for the best health outcomes.

Consensus Statements

- For physical, mental and social health, children and adolescents should acquire a lifestyle that integrates regular physical activity, limited sedentary behaviour, adequate sleep and good eating habits within each 24-hour period.
- Accumulate at least an average of 60 minutes per day of moderate to vigorous intensity physical activity in a week, where more is better.
- Engage in muscle and bone strengthening exercises at least three times a week. This could be part of the daily minimum accumulation of 60 minutes of moderate to vigorous intensity physical activity.
- Engage regularly in a variety of light physical activities throughout the day.
- Limit recreational screen time as much as possible. ***The consensus statement suggests less than 2 hours recreational screen use a day.***
- Build in regular breaks to move around during times of prolonged sitting or inactivity.
- Have regular sleep of at least 9 hours (for 7 to 13 years), at least 8 hours (for 14 to 17 years) and at least 7 hours (for 18 years and above).
- Take the necessary precautions before, during and after exercise and see a doctor if you feel unwell during the exercise.
- Have regular meals consisting of nutritionally balanced foods and drinks to support daily activities, to optimise growth, maturation and development.
- Aim to achieve most or all recommendations on physical activity, sedentary behaviour, sleep and diet for the best results.

Asia-Pacific Consensus Statement on integrated 24-hour activity guidelines for children and adolescents

Children and adolescents are encouraged to adopt a holistic approach towards integrating different types of activity within a 24-hour period—physical activity, sedentary behaviour, sleep and eating habits.¹⁸¹

Based on a review of the evidence and expert input the following recommendations were made:

- Children and adolescents should integrate the recommended physical activity, sedentary behaviour, sleep and eating habits within each 24-hour period for good physical, mental and social health.
- Accumulate a daily average of 60min or more of moderate to vigorous physical activity.
- Engage in a variety of light-intensity physical activities as often as possible throughout the day.
- Take the necessary precautions when engaging in physical activity and seek medical help if you feel any discomfort.
- Sedentary recreational screen time should be limited to 2 hours or less per day.
- Take regular movement breaks when there is prolonged sitting or inactivity.
- Have daily sleep of 9–11hours (for 5–13years old) and 8–10hours (for 14–18years old).
- Take the recommended amounts of foods and drinks that are balanced and nutritious to support growth and daily activities.
- Work towards meeting all the recommendations for physical activity, sedentary behaviour, sleep and eating habits for optimal health and development.

World Health Organization

In 2019, based on a review of the evidence the World Health Organization (WHO) published guidelines on physical activity, sedentary behaviour and sleep for children under 5 years of age.¹⁰ This is in recognition that early childhood is a period of rapid physical and cognitive development and a time during which a child's habits are formed and family lifestyle habits are open to changes and adaptations.

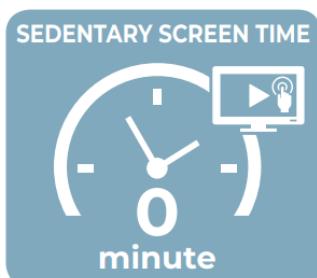
The guidelines are for a 24 hour period as the WHO state that the pattern of overall activity across a 24-hour period needs to be considered, since the day is made up of sleep time, sedentary time and light, moderate or vigorous intensity physical activity.

infants (less than 1 year) should:

Be physically active several times a day in a variety of ways, particularly through interactive floor-based play; more is better. For those not yet mobile, this includes **at least 30 minutes in prone position** (tummy time) spread throughout the day while awake.

Not be restrained for more than 1 hour at a time (e.g. prams/strollers, high chairs, or strapped on a caregiver's back). Screen time is not recommended. When sedentary, engaging in reading and storytelling with a caregiver is encouraged.

Have **14–17 hours** (0–3 months of age) or **12–16 hours** (4–11 months of age) of **good quality sleep**, including naps.

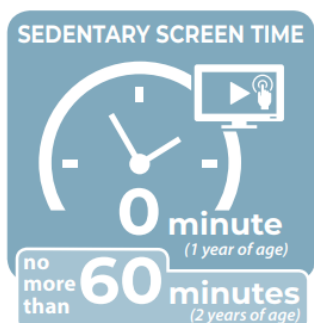


children 1–2 years of age should:

Spend at least 180 minutes in a variety of types of **physical activities** at any intensity, including moderate- to vigorous-intensity physical activity, spread throughout the day; more is better.

Not be restrained for more than 1 hour at a time (e.g. prams/strollers, high chairs, or strapped on a caregiver's back) or sit for extended periods of time. **For 1-year-olds, sedentary screen time (such as watching TV or videos, playing computer games) is not recommended. For those aged 2 years, sedentary screen time should be no more than 1 hour; less is better.** When sedentary, engaging in reading and storytelling with a caregiver is encouraged.

Have **11–14 hours of good quality sleep**, including naps, with regular sleep and wake-up times.

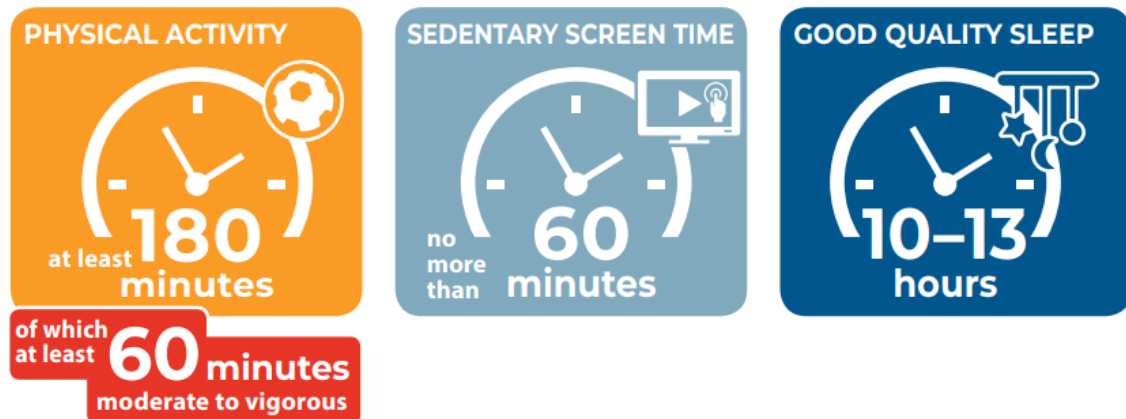


children 3–4 years of age should:

Spend at least 180 minutes in a variety of types of physical activities at any intensity, of which at least 60 minutes is moderate- to vigorous-intensity physical activity, spread throughout the day; more is better.

Not be restrained for more than 1 hour at a time (e.g. prams/strollers) or sit for extended periods of time. **Sedentary screen time should be no more than 1 hour; less is better.** When sedentary, engaging in reading and storytelling with a caregiver is encouraged.

Have 10–13 hours of good quality sleep, which may include a nap, with regular sleep and wake-up times.



The WHO has also published the following guidelines for children aged 5 to 17 years.⁷⁶

Children and adolescents aged 5-17 years:

- Should do at least an average of 60 minutes per day of moderate-to-vigorous intensity, mostly aerobic, physical activity, across the week.
- Should incorporate vigorous intensity aerobic activities, as well as those that strengthen muscle and bone, at least 3 days a week.
- Should limit the amount of time spent being sedentary, particularly the amount of recreational screen time.

Organisation for Economic Co-operation and Development

The OECD recommend a precautionary approach to screen time in childhood, including turning off devices when not in use, switching off screens an hour before bed, and designating times (eg while having dinner or driving) and locations (eg the bedroom) as screen free.⁷

The OECD state that most importantly, it is key to maintain a focus on the activities that are strongly associated with healthy development, such as good quality, regular sleep and quality time spent with family and friends. On the basis that these (and many other factors) are more important than taking a hard line over screen time limits to ensure the best start in life.

United States of America

In 2016 the American Academy of Pediatrics (AAP) reviewed the evidence to date and made a set of recommendations for screen use in children.^{182,183}

- For children younger than 18 months, discourage use of screen media other than video-chatting.
- For children 18 to 24 months of age who want to introduce digital media, choose high-quality programming/apps, and use them together with children, because this is how toddlers learn best. Letting children use media by themselves should be avoided.
- For children age 2 to 5 years, limit screen use to 1 hour per day of high-quality programs. Parents should co-view media with children to help them understand what they are seeing and apply it to the world around them.
- For children age 6 and older, place consistent limits on the time spent using media, and the types of media, and make sure media does not take the place of adequate sleep, physical activity and other behaviours essential to health.
- Develop, consistently follow, and routinely revisit a Family Media Use plan www.HealthyChildren.org/MediaUsePlan.¹⁸⁴
- Designate media free times together (eg family dinners) and media free locations (eg bedrooms) in homes. Promote activities that are likely to facilitate development and health, including positive parenting activities, such as reading, teaching, talking, and playing together.
- Discourage entertainment media while doing homework.
- Avoid exposure to devices or screens for 1 hour before bedtime.
- Ensure that children and adolescents get the recommended amount of daily physical activity (1 hour) and adequate sleep (8 to 12 hours, depending on age).
- Avoid fast-paced programs (young children do not understand them as well), apps with lots of distracting content, and any violent content.
- Turn off televisions and other devices when not in use.
- Avoid using media as the only way to calm children. Although there are intermittent times (eg medical procedures, airplane flights) when media is useful as a soothing strategy, there is concern that using media as strategy to calm could lead to problems with limit setting or the inability of children to develop their own emotion regulation.
- Have ongoing communication with children about online citizenship and safety, including treating others with respect online and offline, avoiding cyberbullying and sexting, being wary of online solicitation, and avoiding communications that can compromise personal privacy and safety.

Canada

Canada's screen time guidance for children is one component in a bundle of three that incorporates sleep, physical activity, and screen time. The 24 hour movement guidelines aim to make the whole day matter.¹⁸⁵



Canada's 24 hour movement guidelines for children and youth (aged 5 to 17 years) were published in 2016.¹⁸⁶ The guidelines were based on systematic reviews of the evidence and expert input. In addition, a stakeholder survey was undertaken (n = 590) and 28

focus groups/stakeholder interviews (n = 104) to gather feedback on draft guidelines and their dissemination.

Canada’s 24 hour movement guidelines for the early years (0 to 4 years) were published in 2017.¹⁸⁷ The guidelines were based on systematic reviews of the evidence and expert input. In addition, a stakeholder survey was undertaken (n = 546), 10 key informant interviews, and 14 focus groups (n = 92 participants) to gather feedback on draft guidelines and their dissemination.

There are also 24 hour movement guidelines for adults and older adults.¹⁸⁵

The following are the Canadian guidelines for children.

A healthy 24 hours includes:

INFANTS (LESS THAN 1 YEAR)

Move

- ★ Being physically active several times in a variety of ways, particularly through interactive floor-based play—more is better.
- ★ For those not yet mobile, this includes at least 30 minutes of tummy time spread throughout the day while awake.

Sleep

- ★ 14 to 17 hours (for those aged 0-3 months)
- ★ 12 to 16 hours (for those aged 4-11 months) of good-quality sleep, including naps.

Sit

- ★ Not being restrained for more than 1 hour at a time (e.g., in a stroller or high chair).
- ★ Screen time is not recommended
- ★ When sedentary, engaging in pursuits such as reading and storytelling with a caregiver is encouraged.

TODDLERS (1-2 YEARS)

Move

- ★ At least 180 minutes spent in a variety of physical activities at any intensity, including energetic play, spread throughout the day—more is better.

Sleep

- ★ 11 to 14 hours of good-quality sleep, including naps, with consistent bedtimes and wake-up times.

Sit

- ★ Not being restrained for more than 1 hour at a time (e.g., in a stroller or high chair) or sitting for extended periods.
- ★ For those younger than 2 years, sedentary screen time is not recommended. For those aged 2 years, sedentary screen time should be no more than 1 hour—less is better.
- ★ When sedentary, engaging in pursuits such as reading and storytelling with a caregiver is encouraged.

PRESCHOOLERS (3-4 YEARS)

Move

- ★ At least 180 minutes spent in a variety of physical activities spread throughout the day, of which at least 60 minutes is energetic play—more is better.

Sleep

- ★ 10 to 13 hours of good-quality sleep, which may include a nap, with consistent bedtimes and wake-up times.

Sit

- ★ Not being restrained for more than 1 hour at a time (e.g., in a stroller or car seat) or sitting for extended periods.
- ★ Sedentary screen time should be no more than 1 hour—less is better.
- ★ When sedentary, engaging in pursuits such as reading and storytelling with a caregiver is encouraged.

Replacing time restrained or sedentary screen time with additional energetic play, and trading indoor for outdoor time, while preserving sufficient sleep, can provide greater health benefits.

For optimal health benefits, children and youth (aged 5–17 years) should achieve high levels of physical activity, low levels of sedentary behaviour, and sufficient sleep each day.

A healthy 24 hours includes:

SWEAT

Moderate to vigorous physical activity

An accumulation of at least 60 minutes per day of moderate to vigorous physical activity involving a variety of aerobic

- ★ activities. Vigorous physical activities, and muscle and bone strengthening activities should each be incorporated at least 3 days per week;

STEP

Light physical activity

- ★ Several hours of a variety of structured and unstructured light physical activities;

SLEEP

Sleep

- ★ Uninterrupted 9 to 11 hours of sleep per night for those aged 5–13 years and 8 to 10 hours per night for those aged 14–17 years, with consistent bed and wake-up times;

SEDENTARY BEHAVIOUR

SEDENTARY BEHAVIOUR

- ★ No more than 2 hours per day of recreational screen time;
- ★ Limited sitting for extended periods.

Preserving sufficient sleep, trading indoor time for outdoor time, and replacing sedentary behaviours and light physical activity with additional moderate to vigorous physical activity can provide greater health benefits.

Canada's Four M's

The Canadian Paediatric Society, Digital Health Task Force has developed guidance on approaches to screen use in childhood.⁴⁶ Recommending that health care providers can promote healthy screen use by counselling every family to remember four essential 'Ms':

MANAGE screen use. Advise parents to:

- Make and regularly review or revise a Family Media Plan, including individualised time and content limits.
- Continue to be present and engaged when screens are used and, whenever possible, co-view and talk about content with children and teens.
- Discourage media multitasking, especially during homework.
- Learn about parental controls and privacy settings.
- Obtain their child's or teen's passwords and login information for devices and social media accounts, to help ensure safety online, and to follow online profiles and activities if concerns arise.
- Speak proactively with children and teens about acceptable and unacceptable online behaviours.

Encourage **MEANINGFUL** screen use. Advise parents to:

- Prioritise daily routines, such as interacting face-to-face, sleep, and physical activity over screen use.
- Prioritise screen activities that are educational, active, or social over those that are passive or unsocial.
- Help children and teens to choose developmentally appropriate content and to recognize problematic content or behaviours.
- Be a part of their children's media lives. For example, join in during video game play and ask about their experiences and encounters online.
- Advocate for schools, child care centres, and after-school programs to consider developing their own plan for digital literacy and screen use.

MODEL healthy screen use:

- Encourage parents to review their own media habits, and plan time for alternative hobbies, outdoor play, and activities.
- Remind parents and adolescents of the dangers of texting or using headphones while driving, walking, jogging, or biking.
- Encourage daily 'screen-free' times, especially for family meals and socializing.
- Ask whether screens are 'off' when not in use, including background TVs.
- Remind parents and teens to avoid screens at least 1 hour before bedtime and discourage recreational screen use in bedrooms.

MONITOR for signs of problematic screen use at any age, including the following:

- Complaints about being bored or unhappy without access to technology.
- Oppositional behaviour in response to screen time limits.
- Screen use that interferes with sleep, school, or face-to-face interactions.
- Screen time that interferes with offline play, physical activity, or socializing face-to-face.
- Negative emotions following online interactions or video games or while texting.
- Let parents know that the occasional occurrence of these signs may be expected, and does not necessarily indicate problematic screen use.

Australia

In 2017, based on a review of the evidence and expert opinion, Australia published 24-hour movement guidelines from birth to 5 years.¹⁸⁸

Guidance is outlined below by age bandings.

Children under 1 year of age:

- Physical activity: Being physically active several times a day in a variety of ways, particularly through supervised interactive floor-based play, including crawling; more is better. For those not yet mobile, this includes at least 30 minutes of tummy time, which includes reaching and grasping, pushing and pulling, spread throughout the day while awake.
- Sedentary behaviour: Not being restrained for more than 1 hour at a time (eg in a stroller, car seat or highchair).
- Screen time is not recommended. When sedentary, engaging in pursuits such as reading, singing, puzzles and storytelling with a caregiver is encouraged.
- Sleep: 14 to 17 hours (for those aged 0–3 months) and 12 to 16 hours (for those aged 4–11 months) of good quality sleep, including naps.

Toddlers (1–2 years):

- Physical activity: At least 180 minutes spent in a variety of physical activities, including energetic play, spread throughout the day; more is better.
- Sedentary behaviour: Not being restrained for more than 1 hour at a time (e.g., in a stroller, car seat or highchair) or sitting for extended periods. For those younger than 2 years, sedentary screen time is not recommended. For those aged 2 years, sedentary screen time should be no more than 1 hour; less is better. When sedentary, engaging

in pursuits such as reading, singing, puzzles and storytelling with a caregiver is encouraged.

- Sleep: 11 to 14 hours of good quality sleep, including naps, with consistent sleep and wake-up times.

Pre-schoolers (3–5 years):

- Physical activity: At least 180 minutes spent in a variety of physical activities, of which at least 60 minutes is energetic play, spread throughout the day; more is better.
- Sedentary behaviour: Not being restrained for more than 1 hour at a time (eg in a stroller or car seat) or sitting for extended periods. Sedentary screen time should be no more than 1 hour; less is better. When sedentary, engaging in pursuits such as reading, singing, puzzles and storytelling with a caregiver is encouraged.
- Sleep: 10 to 13 hours of good quality sleep, which may include a nap, with consistent sleep and wake-up times.

New Zealand

Based on a review of the evidence and expert opinion, the following guidelines have been published.

Children and young people are encouraged to live an active lifestyle with a daily balance of sleep, sedentary behaviour, and physical activity that supports their healthy development.¹⁸⁹

Sit Less, Move More, Sleep Well:

Active play guidelines for under-fives

Regular active play, limited sitting and enough good-quality sleep are important for a child's healthy growth and development.

Sit Less

1. Provide regular activity breaks to limit the amount of time a child spends sitting.
2. Discourage screen time for under-two-year-olds and limit screen time to less than one hour every day for children aged two years or older – less is best!
3. Limit time in equipment that restricts free movement.

Move More

1. Provide fun activities that support physical, social, emotional and spiritual growth (at least three hours every day for toddlers and preschoolers, spread throughout the day).
2. Include plenty of opportunities for active play:
 - that develop movement competence and confidence
 - that provide sufficient challenges to build resilience and encourage creativity through exploration
 - where children are by themselves as well as interacting with others, such as parents, siblings, friends, whānau/family and other caregivers
 - that include a variety of indoor and outdoor activities, especially activities involving nature.

Sleep Well

1. Babies (birth to three months) should have 14 to 17 hours good-quality sleep every day, including daytime sleeps centred round their physical and emotional needs.
2. Infants (four to twelve months) should have 12 to 15 hours good-quality sleep every day, including daytime sleeps, which will tend to decrease as they get closer to one year of age.
3. Toddlers (one to two years inclusive) should have 11 to 14 hours of good-quality sleep every day, including at least one daytime sleep.
4. Preschoolers (three to four years inclusive) should have 10 to 13 hours of good-quality sleep every day, with consistent bedtimes and wake-up times.

When using these guidelines with families of children under-five years of age, it is important to note that any change to the time spent doing one activity affects the time spent doing other activities. Thus, greater health benefits can be gained by switching the amount of time spent in front of a screen with additional energetic play time, while maintaining good-quality sleep time.

Sit Less, Move More, Sleep Well

Physical Activity Guidelines for Children and Young People

For school-aged children and young people (aged 5 to 17 years) high levels of physical activity, low levels of sedentary behaviour and sufficient sleep each day achieves greater health benefits.

A healthy 24 hours includes:



quality uninterrupted sleep of 9 to 11 hours per night for those aged 5 to 13 years and 8 to 10 hours per night for those aged 14 to 17 years, with consistent bed and wake-up times



an accumulation of at least one hour a day of moderate to vigorous physical activity (incorporate vigorous physical activities and activities that strengthen muscles and bones, at least three days a week)



no more than two hours per day of recreational screen time



for the remainder of the day:

- sitting less, moving more – break up sitting time.
- participating in structured and unstructured light physical activities.

Preserving sleep, trading indoor time for outdoor time, and replacing sedentary behaviours and light physical activity with additional moderate to vigorous physical activity can provide greater health benefits.

Germany

Based on a review of the evidence, Germany has developed physical activity guidelines, within these are a set of recommendations related to screen time in childhood.¹⁶⁷

Sitting and using screen media (TV, computer/tablet, smartphone etc.)

- Avoidable sitting times should be reduced to a minimum. In addition to (motorized) transport, e.g. in a baby carrier or child seat, or periods spent inside unnecessarily, this relates in particular to reducing consumption of screen media to a minimum:
 - Infants and toddlers: 0 minutes
 - Pre-school children: as little as possible, maximum of 30 minutes/day
 - Primary school children: as little as possible, maximum of 60 minutes/day
 - Adolescents: as little as possible, maximum of 120 minutes/day

United Kingdom

The Royal College of Paediatrics and Child Health (RCPCH) reviewed of the evidence on the effects of screen time on children's physical and mental health.^{190,191}

The RCPCH has one primary recommendation

"Families should negotiate screen time limits with their children based upon the needs of an individual child, the ways in which screens are used and the degree to which use of screens appears to displace (or not) physical and social activities and sleep."

The RCPCH concluded that the evidence is weak for a threshold to guide children and parents to the appropriate level of screen time and so the RCPCH was unable to recommend a cut-off for children's screen time overall. Equally, because of the lack of evidence on the differential effects of different forms of screen time, they did not recommend a universal cut-off for specific forms of screen time. However, thresholds may be an appropriate part of a family's media planning.

The RCPCH state that the effect of screen time depends so much on context, and the uncertain nature of the evidence, it is impossible to give comprehensive national guidance or limits. However, they recommend that families examine their own screen time regime using the following questions as a guide. If a family can ask themselves (or be asked by others) these questions, and are satisfied with the answers, then they can be reassured that they are likely to be doing as well as they can with this complex issue.

The questions are:

1. Is screen time in your household controlled?
2. Does screen use interfere with what your family wants to do?

3. Does screen use interfere with sleep?

4. Are you able to control snacking during screen time?

The RCPCH state that there is little evidence that any specific intervention can be applied across the population to reduce screen time. However, they have stated that the following practical tips may be helpful to families:

Have a plan and stick to it: this is a principle borrowed from standard parenting practice. It is helpful to sit down in calm moment, as a family, and discuss the boundaries of screen use to adopt, using the questions above as a guide. It is important that:

- Everyone understands the boundaries.
- Family members are praised and, if appropriate, rewarded for respecting these boundaries.
- Boundaries are consistently applied and, if necessary, consequences are put in place.

Be aware, but not intrusive or judgmental: It is important to know what apps and networks young people are engaged with, how these work and what content they are likely to encounter.

It is, however, often counter-productive to insist on monitoring every detail of online activity. An informed and open approach will lead to a more mature approach in the long run.

Think about their own media use: Children will learn more from example than from instruction. It may be that what parents are doing on phones is important, but it is worth pausing to reflect, if children are around and available for interaction, whether it can wait.

Prioritise face-to-face interaction: Online interaction is a valid form of interaction- great relationships can be formed and encouraged online. However, for children to develop the skills and resilience to cope with the world, they need regular interaction in the physical world.

This is especially true for young children who need regular play and interaction with other people, but for older children active, offline play should also be encouraged, as well as regular space for conversation.

While screen-based interaction is enjoyable it does not have the positive developmental effects of in-person interaction. For instance educational apps do not appear to help communication in most children.

Be snack aware: It can be very easy to finish a session of media use, look around and wonder where all these packets came from! If combining snacks with screen use, do so as part of an overall diet plan.

Protect sleep: Most experts advise that children are not exposed to screens for an hour before bed, so that their brains have time to wind down for sleep without the stimulation from the light of the screen (and the content being viewed).

Some manufacturers have introduced 'night-modes' which emit less blue light, but there is no evidence that these are effective so the RCPCH do not think that this makes screen use before bed 'OK'.

The UK Department of Health

The Chief Medical Officer (CMO) supports the RCPCH advice and their key questions.¹⁹² In 2019 the CMO published the following recommendations.

UK Chief Medical Officers' advice for parents and carers on Children and Young People's screen and social media use

Technology can be a wonderful thing but too much time sitting down or using mobile devices can get in the way of important, healthy activities. Here are some tips for balancing screen use with healthy living.

Sleep matters Getting enough, good quality sleep is very important. Leave phones outside the bedroom when it is bedtime.	Sharing sensibly Talk about sharing photos and information online and how photos and words are sometimes manipulated. Parents and carers should never assume that children are happy for their photos to be shared. For everyone – when in doubt, don't upload!	 
Education matters Make sure you and your children are aware of, and abide by, their school's policy on screen time.	Keep moving! Everyone should take a break after a couple of hours sitting or lying down using a screen. It's good to get up and move about a bit. #sitlessmovemore	 
Safety when out and about Advise children to put their screens away while crossing the road or doing an activity that needs their full attention.	Talking helps Talk with children about using screens and what they are watching. A change in behaviour can be a sign they are distressed – make sure they know they can always speak to you or another responsible adult if they feel uncomfortable with screen or social media use.	 
Family time together Screen-free meal times are a good idea – you can enjoy face-to-face conversation, with adults giving their full attention to children.	Use helpful phone features Some devices and platforms have special features – try using these features to keep track of how much time you (and with their permission, your children) spend looking at screens or on social media.	 

The Chief Medical Officer signposts care-givers to the RCPCH advice as well as additional information and tools such as the UK Council for Internet Safety **guide for parents and carers**.¹⁹³ In addition, the UK Safer Internet Centre and Childnet International guidance on **Keeping under 5s safe online**.¹⁹⁴ This has 8 top tips, with additional information and resources provided:

1. Enjoy going online together
2. Establish clear boundaries
3. Supervise your child's use
4. Consider the quality and quantity of online activities
5. Make use of parental tools
6. Start the conversation early
7. Choose age appropriate apps and games
8. Know where to report concerns

France

French Academy of Sciences avoid quantitative guidelines in terms of number of hours of screen time and focus more on qualitative elements. For example, between the ages of 2 and 12 “passive and prolonged exposure of children to television without an interactive and instructive human presence is not advisable”.¹

Taiwan

Parents in Taiwan are legally obliged to stop their children spending too much time using “electronic products” such as video games and televisions. This is outlined in the Protection of Children and Youths Welfare and Rights Act. Article 43 states that children and youth shall not “continue using electronic products for an unreasonable amount of time, causing harm to their physical and mental health”.¹⁹⁵

Under the rules children under the age of two should be completely banned from using electronic devices, 3 year olds limited to 30 minutes of screen time per day and that 4 to 6 year olds be limited to one hour, with a 10-minute break every half hour to rest their eyes.²⁴

Meanwhile under 18s should not be allowed to “constantly use electronic products for a period of time that is not reasonable”.¹⁹⁶ Electronic products are now listed alongside cigarettes and alcohol as potentially dangerous vices.

Parents who fail to comply with the new laws, or rather, fail to enforce it upon their children may be fined NTD\$50,000 (SGD\$2342).¹⁹⁷

It remains unclear how authorities will determine what amount of time is unreasonable.

There is a lack of evidence base to support these guidelines.

China

In 2021 China updated rules limiting the amount of time children can play online games. The restrictions limit children to just three hours of online game playing a week. That is one hour between 8 p.m. and 9 p.m. on Friday, Saturday and Sunday most weeks.¹⁹⁸

The previous limit, set in 2019, was 3 hours on holidays and 1.5 hours on other days. Gaming companies will be barred from providing in-game services to minors outside the stipulated hours and must ensure that they have put real-name registration systems in place.¹⁹⁹

The justification behind this strict decision appears to be multifactorial.

The new rules are part of a campaign to prevent kids from spending too much time on entertainment that communist authorities consider unhealthy. That also includes what officials call the “irrational fan culture” of worshipping celebrities.²⁰⁰

There has been a growing concern in China about gaming addiction among children. Government reports in 2018 stated that about one in 10 Chinese children were addicted to the internet (definitions and details were unable to be accessed).¹⁹⁸ State media (likely representing the government's stance) have framed video game addiction as a social ill, publishing an online report describing online gaming as "spiritual opium". Singling out Tencent Holdings, China's largest video game operator, as a source of the problem.²⁰¹

According to an online question-and-answer explanation by the National Press and Publication Administration, this video game ban is meant to safeguard youth's physical and mental health.²⁰⁰ The administration also claims that Chinese parents have pushed for further regulation on online gaming. According to a report released by the government-funded Beijing Children's Legal Aid and Research Centre, Chinese parents are concerned that children had constantly found new ways to sneak past the limits on gaming hours. Additionally, many parents reported that their children had displayed personality and temperamental changes after becoming addicted to online games.²⁰²

A 2022 systematic review and meta-analysis that looked at screen time and health issues in Chinese school-aged children and adolescents suggested that higher levels of screen time are related with greater risks of various health issues, although the relationships appear to be weak and intertwined with other confounding factors. The pooled odds ratio from 19 studies comparing health risks with the screen time cut-off of 2 hours per day was 1.40. The pooled effect size was 1.29 after trimming 7 studies for publication bias adjustments.²⁰³ In 2016, a study found that about 37% Chinese children used screens for more than 2 hours a day.²⁰⁴

Gaming companies have been extremely cooperative and immediately sought to align themselves with the new restrictions. China's biggest gaming company, Tencent Holdings, has limited gaming time for minors and even banned children under age 12 from making in-game purchases.²⁰⁵ Other social media companies have also followed suit. In the weeks following the announcement of video game restrictions, ByteDance Ltd which owns TikTok and its Chinese version Douyin, implemented its own set of restrictions for users under 14 years. The update restricts young users to 40 minutes of daily usage, and only between the hours of 6am and 10pm.²⁰⁶

Some parents are reported to be supportive of the ban and believe that such measures will effectively curb gaming addiction, while others note that technological addiction may not be restricted to online gaming.²⁰⁰

Chinese youths have taken to social media to express their disappointment with what they perceive to be excessive governmental oversight and a detriment to China's booming E-sports industry.²⁰⁷

These restrictions may appear effective on paper, but enforcement remains an issue. State media has reported an uptick in gaming accounts for rent on ecommerce sites. By paying as little as 33 yuan (\$5), youths can borrow gaming accounts from adult vendors for two hours of use. In 2021 September, Tencent sued over 20 ecommerce sites for providing this practice in September, but such services remain available as of today. Additionally, parents have reported that children have replaced online games with livestreaming platforms such as Douyin for entertainment. Youths are able to manually

turn off the youth restrictions and spend unlimited hours watching online gaming livestreams or other short videos.²⁰⁸

In response, Chinese broadcasting regulators have rolled out further restrictions to govern online behaviour among youths. In September 2021, livestream service operators were banned from allowing youths under 16 to host livestreams. In May 2022, livestream operators were banned from allowing youths under 16 to view content after 10pm and to tip content creators.²⁰⁹ However, such measures are ultimately only as effective as its enforcement – and this responsibility ultimately lies with the parents, not the state.

There is a lack of evidence base to support these guidelines.

Hong Kong

The Department of Health published the following updated guidance in May 2022. The guidance recognises that as smartphones, video chats, online learning, and streaming services become increasingly popular, screen time for children is inevitable to meet their learning and social needs, or as a pastime. The guidance adopts a wider approach to screen time, moving beyond setting time limits to emphasise parental role modeling, engagement, screen-free areas and times, and being physically active.²¹⁰

Screen Time for Your Kids: Mind the Kind and the Time

It is increasingly common for babies and children to learn through electronic media in recent years. While findings on its long-term effectiveness are inconclusive, researches have confirmed that excessive sedentary 'screen activities' will negatively impact children's development in different ways. Health organisations from around the world thus recommend limiting the time children spend on screen products.

Based on the guideline of the WHO, the **Department of Health** advises that

- For children **aged 2 to 5**, there should be **no more than 1 hour** of sedentary screen time per day
- For those **under 2 years of age**, **avoid letting them in contact** with any electronic screen products

However, as smartphones, video chats, online learning, and streaming services become increasingly popular, screen time for children is inevitable to meet their learning and social needs, or as a pastime.

Apart from limiting the time on gadgets, how do parents **choose the right screen products and activities** to facilitate children's learning?

You may consider the **"3 Cs"** below:



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Department of Health

Child

- Choose according to children's **age, abilities and preferences**
- Review children's performance from time to time to decide whether the screen activity is appropriate

Context (in which the screen media is used)

- Parent** is the most important part of the context when children use screen products!
- Research shows that while infants and toddlers may learn through electronic media, learning through real-life interactions is far more effective and efficient
- Young children can learn better if **adults take part** and provide additional explanations, ask questions and help apply the content to daily life

Content

Choose quality content of screen activities that:

- Attracts and engages children
- Has **interactive** elements that **keep children's minds actively involved**, e.g. the character on screen pauses after asking a question to give the child time to respond, or encourages the child to attend to things in **real-life**
- Is **meaningful** to children, e.g. is **relevant** to the child's life, has a **coherent story theme**, or narrated by a (cartoon) character the child is familiar with
- Encourages real-life **social interaction** E.g. asking children to share what they have learned with their parents

Avoid content that :

- Has too many distracting and **non-essential** contents E.g. sudden pop-up images or graphics
- Keeps the child in **"auto-pilot" mode** with **meaningless** actions E.g. pressing screen button repeatedly
- Is **too abstract** for children to understand

To prevent problems arising from screen use, consider the “4 Ss” :

1 Set rules to prevent overuse

- Set **simple rules** for using screen products with children beforehand, including when and where to use the screen products, time limit and the rules, as well as setting aside “screen-free” time and location. Screen use should not be too long, and conflicts can be avoided with prior limit-setting.

Screen Rules

- ask Dad / Mom before use
- No screen in bedroom
- No screen during and after dinner

I'll turn it off when this show ends!

- Since preschoolers have yet to grasp the concept of time, parents can give prior notice before the screen activity ends in ways children can understand, or using tools like timer or hourglass.

2 Stay healthy with routines

- Establish **routine** for children beyond screen time and **arrange something fun** to avoid overuse of digital products. Check out “[Having Fun with Your Kids While Stuck at Home](#)” to know more.
- Exercise regularly**; even when stuck at home, parents and children may try the [Parent-Child Physical Games](#) recommended by StartSmart@school.hk.
- Protect the **eyes** during screen use. Choose gadgets with larger screens, ensure the room is well lit, and maintain a proper sitting position, viewing distance, angle and screen brightness when your child is having screen activities to reduce strain on the eyes. Parents may refer to [Healthy use of Internet and Electronic Screen Products](#) of the Department of Health for details.

3 Stay away from “electronic pacifier”

- Are parents aware that under what circumstances you are more likely to let your child use screen products?

When you or your child get emotional? When you're tired? When your child is bored? Are screen products often used to settle and reward the child?

- If a child often relies on screen devices to settle negative emotions and idling time, he **cannot learn to regulate his emotion and develop self-control**.
- If you find yourself relying on screen products to manage your child's behaviour and emotions, **review your current ways of discipline** and find alternative activities and rewards to replace screen time. Seek support from other family members or professionals when needed.
- To know more about child discipline, you may refer to leaflets including

[Discipline Your Toddler in a Positive Way](#) [Managing the Behaviour of your Preschooler I](#) [Managing the Behaviour of your Preschooler II](#)

4 Set a role model

- Do you often use screen products mindlessly? Are you often distracted by electronic messages and can't respond to his needs promptly when interacting with your child? Consider **putting away your gadget during family time**, so that you can fully engage with your child and **demonstrate healthy use of electronic products**.
- Do you often leave the television on at home (background TV), or watch programmes inappropriate for their age with your children? Studies have found that background TV may have negative impacts on a child's development.
- It is common to have different views on electronic products within a family. Parents need to be aware of your own and the other caregivers' **patterns and attitudes on screen use**, and communicate with mutual respect to come up with acceptable practices for your child to use screen products.

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REFERENCES

- (1) Gottschalk, F. Impacts of Technology Use on Children: Exploring Literature on Brain, Cognition and Well-Being. **2019**, 45.
- (2) Byrne, R.; Terranova, C. O.; Trost, S. G. Measurement of Screen Time among Young Children Aged 0–6 Years: A Systematic Review. *Obesity Reviews* **2021**, 22 (8), e13260. <https://doi.org/10.1111/obr.13260>.
- (3) Jago, R.; Sebire, S. J.; Gorely, T.; Cillero, I. H.; Biddle, S. J. H. "I'm on It 24/7 at the Moment": A Qualitative Examination of Multi-Screen Viewing Behaviours among UK 10-11 Year Olds. *Int J Behav Nutr Phys Act* **2011**, 8, 85. <https://doi.org/10.1186/1479-5868-8-85>.
- (4) Kwasnicka, D.; Dombrowski, S. U.; White, M.; Sniehotta, F. Theoretical Explanations for Maintenance of Behaviour Change: A Systematic Review of Behaviour Theories. *Health Psychol Rev* **2016**, 10 (3), 277–296. <https://doi.org/10.1080/17437199.2016.1151372>.
- (5) LeBlanc, A. G.; Gunnell, K. E.; Prince, S. A.; Saunders, T. J.; Barnes, J. D.; Chaput, J.-P. The Ubiquity of the Screen: An Overview of the Risks and Benefits of Screen Time in Our Modern World. *Translational Journal of the American College of Sports Medicine* **2017**, 2 (17), 104–113. <https://doi.org/10.1249/TJX.0000000000000039>.
- (6) Dickson K et al. 2018. Screen-Based Activities and Children and Young People's Mental Health: A Systematic Map of Reviews. University College London. https://eppi.ioe.ac.uk/cms/Portals/0/PDF%20reviews%20and%20summaries/Systematic%20Map%20of%20Reviews%20on%20Screen-based%20activities_08.01.19.pdf?ver=2019-01-29-155200-517 (accessed 2022-07-18).
- (7) What Do We Know about Children and Technology? OECD. 2019. <https://www.oecd.org/education/ceri/Booklet-21st-century-children.pdf> (accessed 2022-07-11).
- (8) Tremblay, M. S.; Aubert, S.; Barnes, J. D.; Saunders, T. J.; Carson, V.; Latimer-Cheung, A. E.; Chastin, S. F. M.; Altenburg, T. M.; Chinapaw, M. J. M.; SBRN Terminology Consensus Project Participants. Sedentary Behavior Research Network (SBRN) - Terminology Consensus Project Process and Outcome. *Int J Behav Nutr Phys Act* **2017**, 14 (1), 75. <https://doi.org/10.1186/s12966-017-0525-8>.
- (9) Lubans, D. R.; Hesketh, K.; Cliff, D. P.; Barnett, L. M.; Salmon, J.; Dollman, J.; Morgan, P. J.; Hills, A. P.; Hardy, L. L. A Systematic Review of the Validity and Reliability of Sedentary Behaviour Measures Used with Children and Adolescents. *Obesity Reviews* **2011**, 12 (10), 781–799. <https://doi.org/10.1111/j.1467-789X.2011.00896.x>.
- (10) World Health Organization. *Guidelines on Physical Activity, Sedentary Behaviour and Sleep for Children under 5 Years of Age*; World Health Organization, 2019.
- (11) Iannotti, R. J.; Janssen, I.; Haug, E.; Kololo, H.; Annaheim, B.; Borraccino, A. Interrelationships of Adolescent Physical Activity, Screen-Based Sedentary Behaviour, and Social and Psychological Health. *Int J Public Health* **2009**, 54 (Suppl 2), 191–198. <https://doi.org/10.1007/s00038-009-5410-z>.

- (12) Ezzati, M.; World Health Organization. *Comparative Quantification of Health Risks: Global and Regional Burden of Disease Attributable to Selected Major Risk Factors Volume 1. Volume 1.*; World Health Organization: Geneva, 2004.
- (13) Li, C.; Cheng, G.; Sha, T.; Cheng, W.; Yan, Y. The Relationships between Screen Use and Health Indicators among Infants, Toddlers, and Preschoolers: A Meta-Analysis and Systematic Review. *Int J Environ Res Public Health* **2020**, *17* (19), E7324. <https://doi.org/10.3390/ijerph17197324>.
- (14) *STACKING (noun) definition and synonyms | Macmillan Dictionary*. <https://www.macmillandictionary.com/dictionary/british/stacking> (accessed 2022-07-05).
- (15) Yang, L.; Cao, C.; Kantor, E. D.; Nguyen, L. H.; Zheng, X.; Park, Y.; Giovannucci, E. L.; Matthews, C. E.; Colditz, G. A.; Cao, Y. Trends in Sedentary Behavior Among the US Population, 2001-2016. *JAMA* **2019**, *321* (16), 1587–1597. <https://doi.org/10.1001/jama.2019.3636>.
- (16) Arundell, L.; Fletcher, E.; Salmon, J.; Veitch, J.; Hinkley, T. A Systematic Review of the Prevalence of Sedentary Behavior during the After-School Period among Children Aged 5-18 Years. *Int J Behav Nutr Phys Act* **2016**, *13*, 93. <https://doi.org/10.1186/s12966-016-0419-1>.
- (17) *Goodbye outdoors and sleep, hello screens | National Institute of Education, Singapore (NIE)*. <https://nie.edu.sg/about-us/news-events/news/news-detail/goodbye-outdoors-and-sleep-hello-screens> (accessed 2022-07-09).
- (18) Aishworiya, R.; Cai, S.; Chen, H. Y.; Phua, D. Y.; Broekman, B. F. P.; Daniel, L. M.; Chong, Y. S.; Shek, L. P.; Yap, F.; Chan, S.-Y.; Meaney, M. J.; Law, E. C. Television Viewing and Child Cognition in a Longitudinal Birth Cohort in Singapore: The Role of Maternal Factors. *BMC Pediatr* **2019**, *19* (1), 286. <https://doi.org/10.1186/s12887-019-1651-z>.
- (19) Bernard, J. Y.; Padmapriya, N.; Chen, B.; Cai, S.; Tan, K. H.; Yap, F.; Shek, L.; Chong, Y.-S.; Gluckman, P. D.; Godfrey, K. M.; Kramer, M. S.; Saw, S. M.; Müller-Riemenschneider, F. Predictors of Screen Viewing Time in Young Singaporean Children: The GUSTO Cohort. *Int J Behav Nutr Phys Act* **2017**, *14*, 112. <https://doi.org/10.1186/s12966-017-0562-3>.
- (20) Singapore, I. *Associations between parent attitudes and on and off-screen behaviours of preschool children*. Chia, M. Y. H., Chua, T. B. K., Komar, J., & Lua, V. Y. Q. (in review). Iissaar. <https://www.iissaar.com/post/associations-between-parent-attitudes-and-on-and-off-screen-behaviours-of-preschool-children> (accessed 2022-07-09).
- (21) Impact of Screen Viewing during Early Years on Cognitive Development. July 2021. GUSTO. https://thechild.sg/wp-content/uploads/sites/25/2021/07/EI_002_CHILD_Impact-of-Screen-Viewing-on-Cognitive-Development_For-Circulation-digital.pdf (accessed 2022-07-26).
- (22) Ebbeck, M.; Yim, H. Y. B.; Chan, Y.; Goh, M. Singaporean Parents' Views of Their Young Children's Access and Use of Technological Devices. *Early Childhood Educ J* **2016**, *44* (2), 127–134. <https://doi.org/10.1007/s10643-015-0695-4>.
- (23) Tang, L. *S'porean children get first Internet device at age 8, among youngest worldwide: Google*. TODAY. <https://www.todayonline.com/singapore/sporean->

children-get-first-internet-device-age-8-among-youngest-worldwide-google (accessed 2022-07-09).

- (24) Chih, C.; Mazzetta, M. *Taiwan 3-year-olds average over 2 hours of daily screen time: survey - Focus Taiwan*. <https://focustaiwan.tw/society/202203310013> (accessed 2022-07-19).
- (25) COUNCIL ON COMMUNICATIONS AND MEDIA. Media Use in School-Aged Children and Adolescents. *Pediatrics* **2016**, *138* (5), e20162592. <https://doi.org/10.1542/peds.2016-2592>.
- (26) Rideout VJ, Robb MB. The Common Sense Census: Media Use by Kids Age Zero to Eight, 2020. San Francisco, CA: Common Sense Media; 2020. https://www.commonsensemedia.org/sites/default/files/research/report/2020_zero_to_eight_census_final_web.pdf (accessed 2022-07-04).
- (27) The Common Sense Census. Media Use by Tweens and Teens. 2019. <https://www.commonsensemedia.org/sites/default/files/research/report/2019-census-8-to-18-full-report-updated.pdf> (accessed 2022-07-12).
- (28) Xiang, M.; Zhang, Z.; Kuwahara, K. Impact of COVID-19 Pandemic on Children and Adolescents' Lifestyle Behavior Larger than Expected. *Prog Cardiovasc Dis* **2020**, *63* (4), 531–532. <https://doi.org/10.1016/j.pcad.2020.04.013>.
- (29) McGough, K. Pediatric Screen Time. *J Am Assoc Nurse Pract* **2021**, *34* (4), 631–638. <https://doi.org/10.1097/JXX.0000000000000682>.
- (30) Chen, B.; Kui, K. Y.; Padmapriya, N.; Müller, A. M.; Müller-Riemenschneider, F. Correlates of Sedentary Behavior in Asian Preschool-Aged Children: A Systematic Review. *Obes Rev* **2022**, e13485. <https://doi.org/10.1111/obr.13485>.
- (31) Lewis, L.; Povey, R.; Rose, S.; Cowap, L.; Semper, H.; Carey, A.; Bishop, J.; Clark-Carter, D. What Behavior Change Techniques Are Associated with Effective Interventions to Reduce Screen Time in 0-5 Year Olds? A Narrative Systematic Review. *Prev Med Rep* **2021**, *23*, 101429. <https://doi.org/10.1016/j.pmedr.2021.101429>.
- (32) Paudel, S.; Jancey, J.; Subedi, N.; Leavy, J. Correlates of Mobile Screen Media Use among Children Aged 0-8: A Systematic Review. *BMJ Open* **2017**, *7* (10), e014585. <https://doi.org/10.1136/bmjopen-2016-014585>.
- (33) Duch, H.; Fisher, E. M.; Ensari, I.; Harrington, A. Screen Time Use in Children under 3 Years Old: A Systematic Review of Correlates. *Int J Behav Nutr Phys Act* **2013**, *10*, 102. <https://doi.org/10.1186/1479-5868-10-102>.
- (34) LeBlanc, A. G.; Katzmarzyk, P. T.; Barreira, T. V.; Broyles, S. T.; Chaput, J.-P.; Church, T. S.; Fogelholm, M.; Harrington, D. M.; Hu, G.; Kuriyan, R.; Kurpad, A.; Lambert, E. V.; Maher, C.; Maia, J.; Matsudo, V.; Olds, T.; Onywera, V.; Sarmiento, O. L.; Standage, M.; Tudor-Locke, C.; Zhao, P.; Tremblay, M. S.; ISCOLE Research Group. Correlates of Total Sedentary Time and Screen Time in 9-11 Year-Old Children around the World: The International Study of Childhood Obesity, Lifestyle and the Environment. *PLoS One* **2015**, *10* (6), e0129622. <https://doi.org/10.1371/journal.pone.0129622>.
- (35) Chen, B.; Bernard, J. Y.; Padmapriya, N.; Yao, J.; Goh, C.; Tan, K. H.; Yap, F.; Chong, Y.-S.; Shek, L.; Godfrey, K. M.; Chan, S.-Y.; Eriksson, J. G.; Müller-Riemenschneider, F. Socio-Demographic and Maternal Predictors of Adherence to 24-

Hour Movement Guidelines in Singaporean Children. *Int J Behav Nutr Phys Act* **2019**, 16 (1), 70. <https://doi.org/10.1186/s12966-019-0834-1>.

- (36) Ong, J. *The Big Read: Screen time all the time — the unspoken effects of COVID-19 on digital addiction*. CNA. <https://www.channelnewsasia.com/singapore/screen-time-effects-covid-19-work-home-school-children-technology-2233641> (accessed 2022-07-09).
- (37) Bergmann, C.; Dimitrova, N.; Alaslani, K.; Almohammadi, A.; Alroqi, H.; Aussems, S.; Barokova, M.; Davies, C.; Gonzalez-Gomez, N.; Gibson, S. P.; Havron, N.; Horowitz-Kraus, T.; Kanero, J.; Kartushina, N.; Keller, C.; Mayor, J.; Mundry, R.; Shinsky, J.; Mani, N. Young Children's Screen Time during the First COVID-19 Lockdown in 12 Countries. *Sci Rep* **2022**, 12 (1), 2015. <https://doi.org/10.1038/s41598-022-05840-5>.
- (38) Viner, R.; Russell, S.; Saule, R.; Croker, H.; Stansfield, C.; Packer, J.; Nicholls, D.; Goddings, A.-L.; Bonell, C.; Hudson, L.; Hope, S.; Ward, J.; Schwalbe, N.; Morgan, A.; Minozzi, S. School Closures During Social Lockdown and Mental Health, Health Behaviors, and Well-Being Among Children and Adolescents During the First COVID-19 Wave: A Systematic Review. *JAMA Pediatrics* **2022**, 176 (4), 400–409. <https://doi.org/10.1001/jamapediatrics.2021.5840>.
- (39) Trott, M.; Driscoll, R.; Irlado, E.; Pardhan, S. Changes and Correlates of Screen Time in Adults and Children during the COVID-19 Pandemic: A Systematic Review and Meta-Analysis. *EClinicalMedicine* **2022**, 48, 101452. <https://doi.org/10.1016/j.eclinm.2022.101452>.
- (40) Runacres, A.; Mackintosh, K. A.; Knight, R. L.; Sheeran, L.; Thatcher, R.; Shelley, J.; McNarry, M. A. Impact of the COVID-19 Pandemic on Sedentary Time and Behaviour in Children and Adults: A Systematic Review and Meta-Analysis. *Int J Environ Res Public Health* **2021**, 18 (21), 11286. <https://doi.org/10.3390/ijerph182111286>.
- (41) *Research & Policy*. MediaSmarts. <https://mediasmarts.ca/research-policy> (accessed 2022-07-11).
- (42) Auxier, B.; Anderson, M.; Perrin, A.; Turner, E. 4. *Parents' attitudes – and experiences – related to digital technology*. Pew Research Center: Internet, Science & Tech. <https://www.pewresearch.org/internet/2020/07/28/parents-attitudes-and-experiences-related-to-digital-technology/> (accessed 2022-07-09).
- (43) Coyne, S. M.; Padilla-Walker, L. M.; Fraser, A. M.; Fellows, K.; Day, R. D. "Media Time = Family Time": Positive Media Use in Families With Adolescents. *Journal of Adolescent Research* **2014**, 29 (5), 663–688. <https://doi.org/10.1177/0743558414538316>.
- (44) Innocenti, U. O. of R.-. *How Does the Time Children Spend Using Digital Technology Impact Their Mental Well-being, Social Relationships and Physical Activity? An Evidence-focused Literature Review*. UNICEF-IRC. <https://www.unicef-irc.org/publications/925-how-does-the-time-children-spend-using-digital-technology-impact-their-mental-well.html> (accessed 2022-07-05).
- (45) Przybylski, A. K.; Weinstein, N. A Large-Scale Test of the Goldilocks Hypothesis: Quantifying the Relations Between Digital-Screen Use and the Mental Well-Being of Adolescents. *Psychol Sci* **2017**, 28 (2), 204–215. <https://doi.org/10.1177/0956797616678438>.

- (46) Digital Media: Promoting Healthy Screen Use in School-Aged Children and Adolescents. *Paediatr Child Health* **2019**, 24 (6), 402–408. <https://doi.org/10.1093/pch/pxz095>.
- (47) Liu, M.; Wu, L.; Yao, S. Dose-Response Association of Screen Time-Based Sedentary Behaviour in Children and Adolescents and Depression: A Meta-Analysis of Observational Studies. *Br J Sports Med* **2016**, 50 (20), 1252–1258. <https://doi.org/10.1136/bjsports-2015-095084>.
- (48) *Children's Games in the New Media Age: Childlore, Media and the Playground. Chapter 5 Marsh J. The Relationship between Online and Offline Play: Friendship and Exclusion.*, 0 ed.; Richards, C., Burn, A., Eds.; Routledge, 2016. <https://doi.org/10.4324/9781315571591>.
- (49) Peter, J.; Valkenburg, P. M.; Schouten, A. P. Developing a Model of Adolescent Friendship Formation on the Internet. *Cyberpsychol Behav* **2005**, 8 (5), 423–430. <https://doi.org/10.1089/cpb.2005.8.423>.
- (50) Granic, I.; Lobel, A.; Engels, R. C. M. E. The Benefits of Playing Video Games. *American Psychologist* **2014**, 69 (1), 66–78. <https://doi.org/10.1037/a0034857>.
- (51) Gentile, D. A.; Anderson, C. A.; Yukawa, S.; Ihori, N.; Saleem, M.; Ming, L. K.; Shibuya, A.; Liau, A. K.; Khoo, A.; Bushman, B. J.; Huesmann, L. R.; Sakamoto, A. The Effects of Prosocial Video Games on Prosocial Behaviors: International Evidence from Correlational, Longitudinal, and Experimental Studies. *Pers Soc Psychol Bull* **2009**, 35 (6), 752–763. <https://doi.org/10.1177/0146167209333045>.
- (52) Prot, S.; Gentile, D. A.; Anderson, C. A.; Suzuki, K.; Swing, E.; Lim, K. M.; Horiuchi, Y.; Jelic, M.; Krahé, B.; Liuqing, W.; Liau, A. K.; Khoo, A.; Petrescu, P. D.; Sakamoto, A.; Tajima, S.; Toma, R. A.; Warburton, W.; Zhang, X.; Lam, B. C. P. Long-Term Relations Among Prosocial-Media Use, Empathy, and Prosocial Behavior. *Psychol Sci* **2014**, 25 (2), 358–368. <https://doi.org/10.1177/0956797613503854>.
- (53) Eichenbaum A, Bavalier D, Green CS. Video Games: Play That Can Do Serious Good. *Am J Play* 2014;7(1):50–72.
- (54) Powers, K. L.; Brooks, P. J.; Aldrich, N. J.; Palladino, M. A.; Alfieri, L. Effects of Video-Game Play on Information Processing: A Meta-Analytic Investigation. *Psychon Bull Rev* **2013**, 20 (6), 1055–1079. <https://doi.org/10.3758/s13423-013-0418-z>.
- (55) Ferguson, C. J. The Good, the Bad and the Ugly: A Meta-Analytic Review of Positive and Negative Effects of Violent Video Games. *Psychiatr Q* **2007**, 78 (4), 309–316. <https://doi.org/10.1007/s11126-007-9056-9>.
- (56) Thakkar, R. R.; Garrison, M. M.; Christakis, D. A. A Systematic Review for the Effects of Television Viewing by Infants and Preschoolers. *Pediatrics* **2006**, 118 (5), 2025–2031. <https://doi.org/10.1542/peds.2006-1307>.
- (57) O'Neil, H. F.; Wainess, R.; Baker, E. L. Classification of Learning Outcomes: Evidence from the Computer Games Literature. *Curric. j.* **2005**, 16 (4), 455–474. <https://doi.org/10.1080/09585170500384529>.
- (58) Vogel, J. J.; Vogel, D. S.; Cannon-Bowers, J.; Bowers, C. A.; Muse, K.; Wright, M. Computer Gaming and Interactive Simulations for Learning: A Meta-Analysis. *Journal of Educational Computing Research* **2006**, 34 (3), 229–243. <https://doi.org/10.2190/FLHV-K4WA-WPVQ-H0YM>.

- (59) Kato, P. M.; Cole, S. W.; Bradlyn, A. S.; Pollock, B. H. A Video Game Improves Behavioral Outcomes in Adolescents and Young Adults With Cancer: A Randomized Trial. *Pediatrics* **2008**, *122* (2), e305–e317. <https://doi.org/10.1542/peds.2007-3134>.
- (60) Ramdoss, S.; Machalicek, W.; Rispoli, M.; Mulloy, A.; Lang, R.; O'Reilly, M. Computer-Based Interventions to Improve Social and Emotional Skills in Individuals with Autism Spectrum Disorders: A Systematic Review. *Dev Neurorehabil* **2012**, *15* (2), 119–135. <https://doi.org/10.3109/17518423.2011.651655>.
- (61) Chattu, V. K.; Manzar, Md. D.; Kumary, S.; Burman, D.; Spence, D. W.; Pandi-Perumal, S. R. The Global Problem of Insufficient Sleep and Its Serious Public Health Implications. *Healthcare (Basel)* **2018**, *7* (1), 1. <https://doi.org/10.3390/healthcare7010001>.
- (62) Galland, B. C.; Taylor, B. J.; Elder, D. E.; Herbison, P. Normal Sleep Patterns in Infants and Children: A Systematic Review of Observational Studies. *Sleep Medicine Reviews* **2012**, *16* (3), 213–222. <https://doi.org/10.1016/j.smr.2011.06.001>.
- (63) Aishworiya, R.; Chan, P.; Kiing, J.; Chong, S. C.; Laino, A. G.; Tay, S. K. Sleep Behaviour in a Sample of Preschool Children in Singapore. *Ann Acad Med Singap* **2012**, *41* (3), 99–104.
- (64) SingHealth. *What Do We Know About Sleep In Adolescence?* <http://www.singhealth.com.sg:80/news/medical-news-singhealth/sleep-in-adolescence> (accessed 2022-07-08).
- (65) Lo, J. C.; Lee, S. M.; Teo, L. M.; Lim, J.; Gooley, J. J.; Chee, M. W. L. Neurobehavioral Impact of Successive Cycles of Sleep Restriction With and Without Naps in Adolescents. *Sleep* **2016**, *40* (2), zsw042. <https://doi.org/10.1093/sleep/zsw042>.
- (66) Lund, L.; Sølvhøj, I. N.; Danielsen, D.; Andersen, S. Electronic Media Use and Sleep in Children and Adolescents in Western Countries: A Systematic Review. *BMC Public Health* **2021**, *21* (1), 1598. <https://doi.org/10.1186/s12889-021-11640-9>.
- (67) Wood, B.; Rea, M. S.; Plitnick, B.; Figueiro, M. G. Light Level and Duration of Exposure Determine the Impact of Self-Luminous Tablets on Melatonin Suppression. *Appl Ergon* **2013**, *44* (2), 237–240. <https://doi.org/10.1016/j.apergo.2012.07.008>.
- (68) Saunders, T. J.; McIsaac, T.; Campbell, J.; Douillette, K.; Janssen, I.; Tomasone, J. R.; Ross-White, A.; Prince, S. A.; Chaput, J.-P. Timing of Sedentary Behaviour and Access to Sedentary Activities in the Bedroom and Their Association with Sleep Quality and Duration in Children and Youth: A Systematic Review. *Health Promot Chronic Dis Prev Can* **2022**, *42* (4), 139–149. <https://doi.org/10.24095/hpcdp.42.4.03>.
- (69) Zhang, Z.; Sousa-Sá, E.; Pereira, J. R.; Okely, A. D.; Feng, X.; Santos, R. Correlates of Sleep Duration in Early Childhood: A Systematic Review. *Behav Sleep Med* **2021**, *19* (3), 407–425. <https://doi.org/10.1080/15402002.2020.1772264>.
- (70) Janssen, X.; Martin, A.; Hughes, A. R.; Hill, C. M.; Kotronoulas, G.; Hesketh, K. R. Associations of Screen Time, Sedentary Time and Physical Activity with Sleep in under 5s: A Systematic Review and Meta-Analysis. *Sleep Med Rev* **2020**, *49*, 101226. <https://doi.org/10.1016/j.smr.2019.101226>.

- (71) Belmon, L. S.; van Stralen, M. M.; Busch, V.; Harmsen, I. A.; Chinapaw, M. J. M. What Are the Determinants of Children's Sleep Behavior? A Systematic Review of Longitudinal Studies. *Sleep Med Rev* **2019**, *43*, 60–70. <https://doi.org/10.1016/j.smr.2018.09.007>.
- (72) Hale, L.; Guan, S. Screen Time and Sleep among School-Aged Children and Adolescents: A Systematic Literature Review. *Sleep Med Rev* **2015**, *21*, 50–58. <https://doi.org/10.1016/j.smr.2014.07.007>.
- (73) Chaput, J.-P.; Gray, C. E.; Poitras, V. J.; Carson, V.; Gruber, R.; Birken, C. S.; MacLean, J. E.; Aubert, S.; Sampson, M.; Tremblay, M. S. Systematic Review of the Relationships between Sleep Duration and Health Indicators in the Early Years (0–4 Years). *BMC Public Health* **2017**, *17* (Suppl 5), 855. <https://doi.org/10.1186/s12889-017-4850-2>.
- (74) Huang, W. Y.; Ho, R. S.-T.; Tremblay, M. S.; Wong, S. H.-S. Relationships of Physical Activity and Sedentary Behaviour with the Previous and Subsequent Nights' Sleep in Children and Youth: A Systematic Review and Meta-Analysis. *J Sleep Res* **2021**, *30* (6), e13378. <https://doi.org/10.1111/jsr.13378>.
- (75) Krietsch, K. N.; Chardon, M. L.; Beebe, D. W.; Janicke, D. M. Sleep and Weight-Related Factors in Youth: A Systematic Review of Recent Studies. *Sleep Med Rev* **2019**, *46*, 87–96. <https://doi.org/10.1016/j.smr.2019.04.010>.
- (76) Bull, F. C.; Al-Ansari, S. S.; Biddle, S.; Borodulin, K.; Buman, M. P.; Cardon, G.; Carty, C.; Chaput, J.-P.; Chastin, S.; Chou, R.; Dempsey, P. C.; DiPietro, L.; Ekelund, U.; Firth, J.; Friedenreich, C. M.; Garcia, L.; Gichu, M.; Jago, R.; Katzmarzyk, P. T.; Lambert, E.; Leitzmann, M.; Milton, K.; Ortega, F. B.; Ranasinghe, C.; Stamatakis, E.; Tiedemann, A.; Troiano, R. P.; Ploeg, H. P. van der; Wari, V.; Willumsen, J. F. World Health Organization 2020 Guidelines on Physical Activity and Sedentary Behaviour. *Br J Sports Med* **2020**, *54* (24), 1451–1462. <https://doi.org/10.1136/bjsports-2020-102955>.
- (77) Chaput, J.-P.; Gray, C. E.; Poitras, V. J.; Carson, V.; Gruber, R.; Olds, T.; Weiss, S. K.; Connor Gorber, S.; Kho, M. E.; Sampson, M.; Belanger, K.; Eryuzlu, S.; Callender, L.; Tremblay, M. S. Systematic Review of the Relationships between Sleep Duration and Health Indicators in School-Aged Children and Youth. *Appl Physiol Nutr Metab* **2016**, *41* (6 Suppl 3), S266–282. <https://doi.org/10.1139/apnm-2015-0627>.
- (78) Kahn, M.; Schnabel, O.; Gradisar, M.; Rozen, G. S.; Slone, M.; Atzaba-Poria, N.; Tikotzky, L.; Sadeh, A. Sleep, Screen Time and Behaviour Problems in Preschool Children: An Actigraphy Study. *Eur Child Adolesc Psychiatry* **2021**, *30* (11), 1793–1802. <https://doi.org/10.1007/s00787-020-01654-w>.
- (79) Duke-NUS Medical School - 'Need for Sleep': Even elite students are not spared. DukeNUS. <https://www.duke-nus.edu.sg/allnews/need-for-sleep-even-elite-students-are-not-spared> (accessed 2022-07-08).
- (80) Lo, J. C.; Ong, J. L.; Leong, R. L. F.; Gooley, J. J.; Chee, M. W. L. Cognitive Performance, Sleepiness, and Mood in Partially Sleep Deprived Adolescents: The Need for Sleep Study. *Sleep* **2016**, *39* (3), 687–698. <https://doi.org/10.5665/sleep.5552>.
- (81) Huang, S.; Deshpande, A.; Yeo, S.-C.; Lo, J. C.; Chee, M. W. L.; Gooley, J. J. Sleep Restriction Impairs Vocabulary Learning When Adolescents Cram for Exams: The Need for Sleep Study. *Sleep* **2016**, *39* (9), 1681–1690. <https://doi.org/10.5665/sleep.6092>.

- (82) Felső, R.; Lohner, S.; Hollódy, K.; Erhardt, É.; Molnár, D. Relationship between Sleep Duration and Childhood Obesity: Systematic Review Including the Potential Underlying Mechanisms. *Nutr Metab Cardiovasc Dis* **2017**, *27* (9), 751–761. <https://doi.org/10.1016/j.numecd.2017.07.008>.
- (83) Duke-NUS Medical School - Singapore study using wearable trackers links insufficient sleep to increased rate of biological ageing and cardiovascular disease risk. DukeNUS. <https://www.duke-nus.edu.sg/allnews/singapore-study-using-wearable-trackers-links-insufficient-sleep-to-increased-rate-of-biological-ageing-and-cardiovascular-disease-risk> (accessed 2022-07-08).
- (84) SingHealth. *Singaporeans not clocking enough sleep, study finds* (*The Straits Times*, 11 January 2017, Pg B7). <http://www.singhealth.com.sg:80/news/research/singaporeans-not-clocking-enough-sleep-study-finds-the-straits-times-11-january-2017-pg-b7> (accessed 2022-07-08).
- (85) Kontostoli, E.; Jones, A. P.; Pearson, N.; Foley, L.; Biddle, S. J. H.; Atkin, A. J. Age-Related Change in Sedentary Behavior during Childhood and Adolescence: A Systematic Review and Meta-Analysis. *Obes Rev* **2021**, *22* (9), e13263. <https://doi.org/10.1111/obr.13263>.
- (86) van Ekris, E.; Wijndaele, K.; Altenburg, T. M.; Atkin, A. J.; Twisk, J.; Andersen, L. B.; Janz, K. F.; Froberg, K.; Northstone, K.; Page, A. S.; Sardinha, L. B.; van Sluijs, E. M. F.; Chinapaw, M. Tracking of Total Sedentary Time and Sedentary Patterns in Youth: A Pooled Analysis Using the International Children's Accelerometry Database (ICAD). *Int J Behav Nutr Phys Act* **2020**, *17* (1), 1–10. <https://doi.org/10.1186/s12966-020-00960-5>.
- (87) Cunningham, C.; O' Sullivan, R.; Caserotti, P.; Tully, M. A. Consequences of Physical Inactivity in Older Adults: A Systematic Review of Reviews and Meta-Analyses. *Scand J Med Sci Sports* **2020**, *30* (5), 816–827. <https://doi.org/10.1111/sms.13616>.
- (88) Patterson, R.; McNamara, E.; Tainio, M.; de Sá, T. H.; Smith, A. D.; Sharp, S. J.; Edwards, P.; Woodcock, J.; Brage, S.; Wijndaele, K. Sedentary Behaviour and Risk of All-Cause, Cardiovascular and Cancer Mortality, and Incident Type 2 Diabetes: A Systematic Review and Dose Response Meta-Analysis. *Eur J Epidemiol* **2018**, *33* (9), 811–829. <https://doi.org/10.1007/s10654-018-0380-1>.
- (89) Poitras, V. J.; Gray, C. E.; Janssen, X.; Aubert, S.; Carson, V.; Faulkner, G.; Goldfield, G. S.; Reilly, J. J.; Sampson, M.; Tremblay, M. S. Systematic Review of the Relationships between Sedentary Behaviour and Health Indicators in the Early Years (0–4 Years). *BMC Public Health* **2017**, *17* (Suppl 5), 868. <https://doi.org/10.1186/s12889-017-4849-8>.
- (90) Carson, V.; Hunter, S.; Kuzik, N.; Gray, C. E.; Poitras, V. J.; Chaput, J.-P.; Saunders, T. J.; Katzmarzyk, P. T.; Okely, A. D.; Connor Gorber, S.; Kho, M. E.; Sampson, M.; Lee, H.; Tremblay, M. S. Systematic Review of Sedentary Behaviour and Health Indicators in School-Aged Children and Youth: An Update. *Appl Physiol Nutr Metab* **2016**, *41* (6 Suppl 3), S240–265. <https://doi.org/10.1139/apnm-2015-0630>.
- (91) Wu, Y.; Amirfakhraei, A.; Ebrahimzadeh, F.; Jahangiry, L.; Abbasalizad-Farhangi, M. Screen Time and Body Mass Index Among Children and Adolescents: A Systematic Review and Meta-Analysis. *Front Pediatr* **2022**, *10*, 822108. <https://doi.org/10.3389/fped.2022.822108>.
- (92) Musa, S.; Elyamani, R.; Dergaa, I. COVID-19 and Screen-Based Sedentary Behaviour: Systematic Review of Digital Screen Time and Metabolic Syndrome in

Adolescents. *PLoS One* **2022**, *17* (3), e0265560.
<https://doi.org/10.1371/journal.pone.0265560>.

- (93) Fang, K.; Mu, M.; Liu, K.; He, Y. Screen Time and Childhood Overweight/Obesity: A Systematic Review and Meta-Analysis. *Child Care Health Dev* **2019**, *45* (5), 744–753. <https://doi.org/10.1111/cch.12701>.
- (94) Biddle, S. J. H.; García Bengoechea, E.; Wiesner, G. Sedentary Behaviour and Adiposity in Youth: A Systematic Review of Reviews and Analysis of Causality. *Int J Behav Nutr Phys Act* **2017**, *14* (1), 43. <https://doi.org/10.1186/s12966-017-0497-8>.
- (95) de Rezende, L. F. M.; Rodrigues Lopes, M.; Rey-López, J. P.; Matsudo, V. K. R.; Luiz, O. do C. Sedentary Behavior and Health Outcomes: An Overview of Systematic Reviews. *PLoS One* **2014**, *9* (8), e105620. <https://doi.org/10.1371/journal.pone.0105620>.
- (96) van Ekris, E.; Altenburg, T. M.; Singh, A. S.; Proper, K. I.; Heymans, M. W.; Chinapaw, M. J. M. An Evidence-Update on the Prospective Relationship between Childhood Sedentary Behaviour and Biomedical Health Indicators: A Systematic Review and Meta-Analysis. *Obes Rev* **2016**, *17* (9), 833–849. <https://doi.org/10.1111/obr.12426>.
- (97) Shao, T.; Wang, L.; Chen, H. Association Between Sedentary Behavior and Obesity in School-Age Children in China: A Systematic Review of Evidence. *Curr Pharm Des* **2020**, *26* (39), 5012–5020. <https://doi.org/10.2174/1381612826666200707132328>.
- (98) Health Organization. *Obesity and overweight*. <https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight> (accessed 2022-07-07).
- (99) Stiglic, N.; Viner, R. M. Effects of Screen time on the Health and Well-Being of Children and Adolescents: A Systematic Review of Reviews. *BMJ Open* **2019**, *9* (1), e023191. <https://doi.org/10.1136/bmjopen-2018-023191>.
- (100) Paes, V. M.; Ong, K. K.; Lakshman, R. Factors Influencing Obesogenic Dietary Intake in Young Children (0–6 Years): Systematic Review of Qualitative Evidence. *BMJ Open* **2015**, *5* (9), e007396. <https://doi.org/10.1136/bmjopen-2014-007396>.
- (101) Costigan, S. A.; Barnett, L.; Plotnikoff, R. C.; Lubans, D. R. The Health Indicators Associated with Screen-Based Sedentary Behavior among Adolescent Girls: A Systematic Review. *J Adolesc Health* **2013**, *52* (4), 382–392. <https://doi.org/10.1016/j.jadohealth.2012.07.018>.
- (102) Marsh, S.; Ni Mhurchu, C.; Maddison, R. The Non-Advertising Effects of Screen-Based Sedentary Activities on Acute Eating Behaviours in Children, Adolescents, and Young Adults. A Systematic Review. *Appetite* **2013**, *71*, 259–273. <https://doi.org/10.1016/j.appet.2013.08.017>.
- (103) Zink, J.; Belcher, B. R.; Imm, K.; Leventhal, A. M. The Relationship between Screen-Based Sedentary Behaviors and Symptoms of Depression and Anxiety in Youth: A Systematic Review of Moderating Variables. *BMC Public Health* **2020**, *20* (1), 1–37. <https://doi.org/10.1186/s12889-020-08572-1>.
- (104) Keikha, M.; Qorbani, M.; Kazemi Tabaei, M. S.; Djalalinia, S.; Kelishadi, R. Screen Time Activities and Aggressive Behaviors Among Children and Adolescents: A Systematic Review. *Int J Prev Med* **2020**, *11*, 59. https://doi.org/10.4103/ijpvm.IJPVM_71_20.

- (105) American Psychiatric Association. *Psychiatry.org - Internet Gaming*. <https://psychiatry.org:443/patients-families/internet-gaming> (accessed 2022-07-18).
- (106) King, D. L.; Haagsma, M. C.; Delfabbro, P. H.; Gradisar, M.; Griffiths, M. D. Toward a Consensus Definition of Pathological Video-Gaming: A Systematic Review of Psychometric Assessment Tools. *Clinical Psychology Review* **2013**, 33 (3), 331–342. <https://doi.org/10.1016/j.cpr.2013.01.002>.
- (107) Kimball, H.; Cohen, Y. The Child Mind Institute Is an Independent, National Nonprofit Dedicated to Transforming the Lives of Children and Families Struggling with Mental Health and Learning Disorders. Our Teams Work Every Day to Deliver the Highest Standards of Care, Advance the Science of the Developing Brain and Empower Parents, Professionals and Policymakers to Support Children When and Where They Need It Most. *Social Media* 19.
- (108) Kuss, D. J.; Griffiths, M. D. Internet and Gaming Addiction: A Systematic Literature Review of Neuroimaging Studies. *Brain Sci* **2012**, 2 (3), 347–374. <https://doi.org/10.3390/brainsci2030347>.
- (109) Aarseth, E.; Bean, A. M.; Boonen, H.; Colder Carras, M.; Coulson, M.; Das, D.; Deleuze, J.; Dunkels, E.; Edman, J.; Ferguson, C. J.; Haagsma, M. C.; Helmersson Bergmark, K.; Hussain, Z.; Jansz, J.; Kardefelt-Winther, D.; Kutner, L.; Markey, P.; Nielsen, R. K. L.; Prause, N.; Przybylski, A.; Quandt, T.; Schimmenti, A.; Starcevic, V.; Stutman, G.; Van Looy, J.; Van Rooij, A. J. Scholars' Open Debate Paper on the World Health Organization ICD-11 Gaming Disorder Proposal. *J Behav Addict* **2017**, 6 (3), 267–270. <https://doi.org/10.1556/2006.5.2016.088>.
- (110) Sohn, S. Y.; Rees, P.; Wildridge, B.; Kalk, N. J.; Carter, B. Prevalence of Problematic Smartphone Usage and Associated Mental Health Outcomes amongst Children and Young People: A Systematic Review, Meta-Analysis and GRADE of the Evidence. *BMC Psychiatry* **2019**, 19 (1), 356. <https://doi.org/10.1186/s12888-019-2350-x>.
- (111) Wang, B.-Q.; Yao, N.-Q.; Zhou, X.; Liu, J.; Lv, Z.-T. The Association between Attention Deficit/Hyperactivity Disorder and Internet Addiction: A Systematic Review and Meta-Analysis. *BMC Psychiatry* **2017**, 17 (1), 260. <https://doi.org/10.1186/s12888-017-1408-x>.
- (112) World Health Organization. *Public Health Implications of Excessive Use of the Internet, Computers, Smartphones and Similar Electronic Devices: Meeting Report, Main Meeting Hall, Foundation for Promotion of Cancer Research, National Cancer Research Centre, Tokyo, Japan, 27-29 August 2014*; World Health Organization, 2015.
- (113) Holland, G.; Tiggemann, M. A Systematic Review of the Impact of the Use of Social Networking Sites on Body Image and Disordered Eating Outcomes. *Body Image* **2016**, 17, 100–110. <https://doi.org/10.1016/j.bodyim.2016.02.008>.
- (114) Cataldo, I.; Lepri, B.; Neoh, M. J. Y.; Esposito, G. Social Media Usage and Development of Psychiatric Disorders in Childhood and Adolescence: A Review. *Front Psychiatry* **2020**, 11, 508595. <https://doi.org/10.3389/fpsy.2020.508595>.
- (115) Padín, P. F.; González-Rodríguez, R.; Verde-Diego, C.; Vázquez-Pérez, R. Social Media and Eating Disorder Psychopathology: A Systematic Review. *Cyberpsychology: Journal of Psychosocial Research on Cyberspace* **2021**, 15 (3). <https://doi.org/10.5817/CP2021-3-6>.

- (116) Vaillancourt, T.; Brittain, H. L.; McDougall, P.; Duku, E. Longitudinal Links between Childhood Peer Victimization, Internalizing and Externalizing Problems, and Academic Functioning: Developmental Cascades. *J Abnorm Child Psychol* **2013**, *41* (8), 1203–1215. <https://doi.org/10.1007/s10802-013-9781-5>.
- (117) John, A.; Glendenning, A. C.; Marchant, A.; Montgomery, P.; Stewart, A.; Wood, S.; Lloyd, K.; Hawton, K. Self-Harm, Suicidal Behaviours, and Cyberbullying in Children and Young People: Systematic Review. *J Med Internet Res* **2018**, *20* (4), e129. <https://doi.org/10.2196/jmir.9044>.
- (118) *Child Safety Online: A Practical Guide for Providers of Social Media and Interactive Services*. UK Council for Child Internet Safety. 2016. https://Assets.Publishing.Service.Gov.Uk/Government/Uploads/System/Uploads/Attachment_data/File/759011/Ukccis_guide-Final__3_.Pdf; p 60.
- (119) Temple, J. R.; Choi, H. Longitudinal Association between Teen Sexting and Sexual Behavior. *Pediatrics* **2014**, *134* (5), e1287-1292. <https://doi.org/10.1542/peds.2014-1974>.
- (120) Mitchell, K. J.; Finkelhor, D.; Wolak, J. Youth Internet Users at Risk for the Most Serious Online Sexual Solicitations. *Am J Prev Med* **2007**, *32* (6), 532–537. <https://doi.org/10.1016/j.amepre.2007.02.001>.
- (121) Li, S.; Guo, J.; Zheng, K.; Shi, M.; Huang, T. Is Sedentary Behavior Associated With Executive Function in Children and Adolescents? A Systematic Review. *Front Public Health* **2022**, *10*, 832845. <https://doi.org/10.3389/fpubh.2022.832845>.
- (122) Law, E.; et al. PrePrint: Associations Between Infant Screen Use, EEG Markers, and Cognitive Outcomes A Mediation Analysis. Singapore.
- (123) Carson, V.; Kuzik, N.; Hunter, S.; Wiebe, S. A.; Spence, J. C.; Friedman, A.; Tremblay, M. S.; Slater, L. G.; Hinkley, T. Systematic Review of Sedentary Behavior and Cognitive Development in Early Childhood. *Prev Med* **2015**, *78*, 115–122. <https://doi.org/10.1016/j.ypmed.2015.07.016>.
- (124) Rocha, B.; Nunes, C. Benefits and Damages of the Use of Touchscreen Devices for the Development and Behavior of Children under 5 Years Old-a Systematic Review. *Psicol Reflex Crit* **2020**, *33* (1), 24. <https://doi.org/10.1186/s41155-020-00163-8>.
- (125) Karani, N. F.; Sher, J.; Mophosho, M. The Influence of Screen Time on Children's Language Development: A Scoping Review. *S Afr J Commun Disord* **2022**, *69* (1), e1–e7. <https://doi.org/10.4102/sajcd.v69i1.825>.
- (126) Madigan, S.; McArthur, B. A.; Anhorn, C.; Eirich, R.; Christakis, D. A. Associations Between Screen Use and Child Language Skills: A Systematic Review and Meta-Analysis. *JAMA Pediatr* **2020**, *174* (7), 665–675. <https://doi.org/10.1001/jamapediatrics.2020.0327>.
- (127) Adelantado-Renau, M.; Moliner-Urdiales, D.; Caverro-Redondo, I.; Beltran-Valls, M. R.; Martínez-Vizcaíno, V.; Álvarez-Bueno, C. Association Between Screen Media Use and Academic Performance Among Children and Adolescents: A Systematic Review and Meta-Analysis. *JAMA Pediatr* **2019**, *173* (11), 1058–1067. <https://doi.org/10.1001/jamapediatrics.2019.3176>.
- (128) Santos, R. M. S.; Mendes, C. G.; Marques Miranda, D.; Romano-Silva, M. A. The Association between Screen Time and Attention in Children: A Systematic Review.

Dev Neuropsychol **2022**, 47 (4), 175–192.
<https://doi.org/10.1080/87565641.2022.2064863>.

- (129) Foreman, J.; Salim, A. T.; Praveen, A.; Fonseka, D.; Ting, D. S. W.; Guang He, M.; Bourne, R. R. A.; Crowston, J.; Wong, T. Y.; Dirani, M. Association between Digital Smart Device Use and Myopia: A Systematic Review and Meta-Analysis. *Lancet Digit Health* **2021**, 3 (12), e806–e818. [https://doi.org/10.1016/S2589-7500\(21\)00135-7](https://doi.org/10.1016/S2589-7500(21)00135-7).
- (130) Lanca, C.; Saw, S.-M. The Association between Digital Screen Time and Myopia: A Systematic Review. *Ophthalmic Physiol Opt* **2020**, 40 (2), 216–229. <https://doi.org/10.1111/opo.12657>.
- (131) Wang, J.; Li, M.; Zhu, D.; Cao, Y. Smartphone Overuse and Visual Impairment in Children and Young Adults: Systematic Review and Meta-Analysis. *J Med Internet Res* **2020**, 22 (12), e21923. <https://doi.org/10.2196/21923>.
- (132) Yang, M.; Guo, W.; Yang, C.; Tang, J.; Huang, Q.; Feng, S.; Jiang, A.; Xu, X.; Jiang, G. Mobile Phone Use and Glioma Risk: A Systematic Review and Meta-Analysis. *PLoS One* **2017**, 12 (5), e0175136. <https://doi.org/10.1371/journal.pone.0175136>.
- (133) Prasad, M.; Kathuria, P.; Nair, P.; Kumar, A.; Prasad, K. Mobile Phone Use and Risk of Brain Tumours: A Systematic Review of Association between Study Quality, Source of Funding, and Research Outcomes. *Neurol Sci* **2017**, 38 (5), 797–810. <https://doi.org/10.1007/s10072-017-2850-8>.
- (134) Slobodin, O.; Heffler, K. F.; Davidovitch, M. Screen Media and Autism Spectrum Disorder: A Systematic Literature Review. *J Dev Behav Pediatr* **2019**, 40 (4), 303–311. <https://doi.org/10.1097/DBP.0000000000000654>.
- (135) Lin, J.; Magiati, I.; Chiong, S. H. R.; Singhal, S.; Riard, N.; Ng, I. H.-X.; Muller-Riemenschneider, F.; Wong, C. M. The Relationship Among Screen Use, Sleep, and Emotional/Behavioral Difficulties in Preschool Children with Neurodevelopmental Disorders. *J Dev Behav Pediatr* **2019**, 40 (7), 519–529. <https://doi.org/10.1097/DBP.0000000000000683>.
- (136) Wong, C. M.; Koh, H. C.; Lin, J.; Chiong, S. H. R.; Singhal, S.; Riard, N.; Muller-Riemenschneider, F.; Magiati, I. G343 The Influence of Parental Screen Time and Attitudes on Screen Use in Preschool Children Attending a Developmental Clinic. *Archives of Disease in Childhood* **2019**, 104 (Suppl 2), A140–A140. <https://doi.org/10.1136/archdischild-2019-rcpch.332>.
- (137) Ferguson, C. J.; Beresin, E. Social Science’s Curious War with Pop Culture and How It Was Lost: The Media Violence Debate and the Risks It Holds for Social Science. *Prev Med* **2017**, 99, 69–76. <https://doi.org/10.1016/j.ypmed.2017.02.009>.
- (138) Straker, L.; Zabatiero, J.; Danby, S.; Thorpe, K.; Edwards, S. Conflicting Guidelines on Young Children’s Screen Time and Use of Digital Technology Create Policy and Practice Dilemmas. *J Pediatr* **2018**, 202, 300–303. <https://doi.org/10.1016/j.jpeds.2018.07.019>.
- (139) Tapia-Serrano, M. A.; Sevil-Serrano, J.; Sánchez-Miguel, P. A.; López-Gil, J. F.; Tremblay, M. S.; García-Hermoso, A. Prevalence of Meeting 24-Hour Movement Guidelines from Pre-School to Adolescence: A Systematic Review and Meta-Analysis Including 387,437 Participants and 23 Countries. *Journal of Sport and Health Science* **2022**. <https://doi.org/10.1016/j.jshs.2022.01.005>.

- (140) The Singapore Integrated 24-Hour Activity Guidelines for Early Childhood by Integrated Platform for Research in Advancing Metabolic Health Outcomes of Women and Children (IPRAMHO). 2021. [https://www.ams.edu.sg/view-pdf.aspx?file=media%5C5940_fi_169.pdf&ofile=CPCHS+-+Singapore+Integrated+24+Hr+Activity+Guidelines+2020+\(Final\)+20200108.pdf](https://www.ams.edu.sg/view-pdf.aspx?file=media%5C5940_fi_169.pdf&ofile=CPCHS+-+Singapore+Integrated+24+Hr+Activity+Guidelines+2020+(Final)+20200108.pdf) (accessed 2022-07-15).
- (141) Sampasa-Kanyinga, H.; Colman, I.; Goldfield, G. S.; Janssen, I.; Wang, J.; Podinich, I.; Tremblay, M. S.; Saunders, T. J.; Sampson, M.; Chaput, J.-P. Combinations of Physical Activity, Sedentary Time, and Sleep Duration and Their Associations with Depressive Symptoms and Other Mental Health Problems in Children and Adolescents: A Systematic Review. *Int J Behav Nutr Phys Act* **2020**, *17*, 72. <https://doi.org/10.1186/s12966-020-00976-x>.
- (142) Saunders, T. J.; Gray, C. E.; Poitras, V. J.; Chaput, J.-P.; Janssen, I.; Katzmarzyk, P. T.; Olds, T.; Connor Gorber, S.; Kho, M. E.; Sampson, M.; Tremblay, M. S.; Carson, V. Combinations of Physical Activity, Sedentary Behaviour and Sleep: Relationships with Health Indicators in School-Aged Children and Youth. *Appl Physiol Nutr Metab* **2016**, *41* (6 Suppl 3), S283-293. <https://doi.org/10.1139/apnm-2015-0626>.
- (143) McArthur, B. A.; Volkova, V.; Tomopoulos, S.; Madigan, S. Global Prevalence of Meeting Screen Time Guidelines Among Children 5 Years and Younger: A Systematic Review and Meta-Analysis. *JAMA Pediatr* **2022**, *176* (4), 373–383. <https://doi.org/10.1001/jamapediatrics.2021.6386>.
- (144) Downing, K. L.; Hnatiuk, J.; Hesketh, K. D. Prevalence of Sedentary Behavior in Children under 2years: A Systematic Review. *Prev Med* **2015**, *78*, 105–114. <https://doi.org/10.1016/j.ypmed.2015.07.019>.
- (145) World Health Organization. Regional Office for Europe. *Growing up Unequal: Gender and Socioeconomic Differences in Young People's Health and Well-Being*; World Health Organization. Regional Office for Europe, 2016.
- (146) Tremblay, M. S.; Barnes, J. D.; González, S. A.; Katzmarzyk, P. T.; Onywera, V. O.; Reilly, J. J.; Tomkinson, G. R.; Global Matrix 2.0 Research Team. Global Matrix 2.0: Report Card Grades on the Physical Activity of Children and Youth Comparing 38 Countries. *J Phys Act Health* **2016**, *13* (11 Suppl 2), S343–S366. <https://doi.org/10.1123/jpah.2016-0594>.
- (147) Chia, M. Y. H.; Tay, L. Y.; Chua, T. B. K. Quality of Life and Meeting 24-h WHO Guidelines Among Preschool Children in Singapore. *Early Childhood Educ J* **2020**, *48* (3), 313–323. <https://doi.org/10.1007/s10643-019-00987-9>.
- (148) admin. *Too much screen time for toddlers may lead to unhealthy behaviours in later childhood*. The Sedentary Behaviour Research Network (SBRN). <https://www.sedentarybehaviour.org/2020/03/12/too-much-screen-time-for-toddlers-may-lead-to-unhealthy-behaviours-in-later-childhood/> (accessed 2022-07-09).
- (149) Chen, B.; Bernard, J. Y.; Padmapriya, N.; Ning, Y.; Cai, S.; Lança, C.; Tan, K. H.; Yap, F.; Chong, Y.-S.; Shek, L.; Godfrey, K. M.; Saw, S. M.; Chan, S.-Y.; Eriksson, J. G.; Tan, C. S.; Müller-Riemenschneider, F. Associations between Early-Life Screen Viewing and 24 Hour Movement Behaviours: Findings from a Longitudinal Birth Cohort Study. *The Lancet Child & Adolescent Health* **2020**, *4* (3), 201–209. [https://doi.org/10.1016/S2352-4642\(19\)30424-9](https://doi.org/10.1016/S2352-4642(19)30424-9).

- (150) Maniccia, D. M.; Davison, K. K.; Marshall, S. J.; Manganello, J. A.; Dennison, B. A. A Meta-Analysis of Interventions That Target Children's Screen Time for Reduction. *Pediatrics* **2011**, 128 (1), e193-210. <https://doi.org/10.1542/peds.2010-2353>.
- (151) Xu, H.; Wen, L. M.; Rissel, C. Associations of Parental Influences with Physical Activity and Screen Time among Young Children: A Systematic Review. *J Obes* **2015**, 2015, 546925. <https://doi.org/10.1155/2015/546925>.
- (152) Martin, K. B.; Bednarz, J. M.; Aromataris, E. C. Interventions to Control Children's Screen Use and Their Effect on Sleep: A Systematic Review and Meta-Analysis. *Journal of Sleep Research* **2021**, 30 (3), e13130. <https://doi.org/10.1111/jsr.13130>.
- (153) Downing, K. L.; Hnatiuk, J. A.; Hinkley, T.; Salmon, J.; Hesketh, K. D. Interventions to Reduce Sedentary Behaviour in 0-5-Year-Olds: A Systematic Review and Meta-Analysis of Randomised Controlled Trials. *Br J Sports Med* **2018**, 52 (5), 314-321. <https://doi.org/10.1136/bjsports-2016-096634>.
- (154) Wahi, G.; Parkin, P. C.; Beyene, J.; Uleryk, E. M.; Birken, C. S. Effectiveness of Interventions Aimed at Reducing Screen Time in Children: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Arch Pediatr Adolesc Med* **2011**, 165 (11), 979-986. <https://doi.org/10.1001/archpediatrics.2011.122>.
- (155) Stierlin, A. S.; De Lepeleere, S.; Cardon, G.; Dargent-Molina, P.; Hoffmann, B.; Murphy, M. H.; Kennedy, A.; O'Donoghue, G.; Chastin, S. F. M.; De Craemer, M.; DEDIPAC consortium. A Systematic Review of Determinants of Sedentary Behaviour in Youth: A DEDIPAC-Study. *Int J Behav Nutr Phys Act* **2015**, 12, 133. <https://doi.org/10.1186/s12966-015-0291-4>.
- (156) Padmapriya, N.; Chen, B.; Goh, C. M. J. L.; Shek, L. P. C.; Chong, Y. S.; Tan, K. H.; Chan, S.-Y.; Yap, F.; Godfrey, K. M.; Lee, Y. S.; Eriksson, J. G.; Bernard, J. Y.; Müller-Riemenschneider, F. 24-Hour Movement Behaviour Profiles and Their Transition in Children Aged 5.5 and 8 Years - Findings from a Prospective Cohort Study. *Int J Behav Nutr Phys Act* **2021**, 18 (1), 145. <https://doi.org/10.1186/s12966-021-01210-y>.
- (157) Waters, E.; Silva-Sanigorski, A. de; Burford, B. J.; Brown, T.; Campbell, K. J.; Gao, Y.; Armstrong, R.; Prosser, L.; Summerbell, C. D. Interventions for Preventing Obesity in Children. *Cochrane Database of Systematic Reviews* **2011**, No. 12. <https://doi.org/10.1002/14651858.CD001871.pub3>.
- (158) Marsh, S.; Foley, L. S.; Wilks, D. C.; Maddison, R. Family-Based Interventions for Reducing Sedentary Time in Youth: A Systematic Review of Randomized Controlled Trials. *Obes Rev* **2014**, 15 (2), 117-133. <https://doi.org/10.1111/obr.12105>.
- (159) Borrelli, B.; Tooley, E. M.; Scott-Sheldon, L. A. J. Motivational Interviewing for Parent-Child Health Interventions: A Systematic Review and Meta-Analysis. *Pediatr Dent* **2015**, 37 (3), 254-265.
- (160) Schmidt, M. E.; Haines, J.; O'Brien, A.; McDonald, J.; Price, S.; Sherry, B.; Taveras, E. M. Systematic Review of Effective Strategies for Reducing Screen Time among Young Children. *Obesity (Silver Spring)* **2012**, 20 (7), 1338-1354. <https://doi.org/10.1038/oby.2011.348>.
- (161) Jago, R.; Edwards, M. J.; Urbanski, C. R.; Sebire, S. J. General and Specific Approaches to Media Parenting: A Systematic Review of Current Measures, Associations with Screen-Viewing, and Measurement Implications. *Childhood Obesity* **2013**, 9 (s1), S-51. <https://doi.org/10.1089/chi.2013.0031>.

- (162) Nielsen, P.; Favez, N.; Liddle, H.; Rigter, H. Linking Parental Mediation Practices to Adolescents' Problematic Online Screen Use: A Systematic Literature Review. *J Behav Addict* **2019**, *8* (4), 649–663. <https://doi.org/10.1556/2006.8.2019.61>.
- (163) Nguyen, P.; Le, L. K.-D.; Nguyen, D.; Gao, L.; Dunstan, D. W.; Moodie, M. The Effectiveness of Sedentary Behaviour Interventions on Sitting Time and Screen Time in Children and Adults: An Umbrella Review of Systematic Reviews. *Int J Behav Nutr Phys Act* **2020**, *17* (1), 1–11. <https://doi.org/10.1186/s12966-020-01009-3>.
- (164) Oh, C.; Carducci, B.; Vaivada, T.; Bhutta, Z. A. Interventions to Promote Physical Activity and Healthy Digital Media Use in Children and Adolescents: A Systematic Review. *Pediatrics* **2022**, *149* (Suppl 5), e2021053852I. <https://doi.org/10.1542/peds.2021-053852I>.
- (165) Ramsey Buchanan, L.; Rooks-Peck, C. R.; Finnie, R. K. C.; Wethington, H. R.; Jacob, V.; Fulton, J. E.; Johnson, D. B.; Kahwati, L. C.; Pratt, C. A.; Ramirez, G.; Mercer, S. L.; Glanz, K.; Community Preventive Services Task Force. Reducing Recreational Sedentary Screen Time: A Community Guide Systematic Review. *Am J Prev Med* **2016**, *50* (3), 402–415. <https://doi.org/10.1016/j.amepre.2015.09.030>.
- (166) Altenburg, T. M.; Kist-van Holthe, J.; Chinapaw, M. J. M. Effectiveness of Intervention Strategies Exclusively Targeting Reductions in Children's Sedentary Time: A Systematic Review of the Literature. *Int J Behav Nutr Phys Act* **2016**, *13*, 65. <https://doi.org/10.1186/s12966-016-0387-5>.
- (167) Alfred Rütten & Klaus Pfeifer (Eds.) *National Recommendations for Physical Activity and Physical Activity Promotion. Federal Ministry of Health. Germany. 2016.*
- (168) Gray, C.; Gibbons, R.; Larouche, R.; Sandseter, E. B. H.; Bienenstock, A.; Brussoni, M.; Chabot, G.; Herrington, S.; Janssen, I.; Pickett, W.; Power, M.; Stanger, N.; Sampson, M.; Tremblay, M. S. What Is the Relationship between Outdoor Time and Physical Activity, Sedentary Behaviour, and Physical Fitness in Children? A Systematic Review. *International Journal of Environmental Research and Public Health* **2015**, *12* (6), 6455–6474. <https://doi.org/10.3390/ijerph120606455>.
- (169) Wheaton, A. G.; Chapman, D. P.; Croft, J. B. School Start Times, Sleep, Behavioral, Health, and Academic Outcomes: A Review of the Literature. *J Sch Health* **2016**, *86* (5), 363–381. <https://doi.org/10.1111/josh.12388>.
- (170) AY2018 Sec 1 Posting | Nanyang Girls' High School. <https://www.nygh.edu.sg/news/ay2018-sec-1-posting> (accessed 2022-07-09).
- (171) MOE. Minister for Education Question: Whether there are plans to re-evaluate school start times especially with most schools currently operating in single-session mode. <http://www.moe.gov.sg/news/parliamentary-replies/20210803-school-start-time> (accessed 2022-07-14).
- (172) Black, A. P.; D'Onise, K.; McDermott, R.; Vally, H.; O'Dea, K. How Effective Are Family-Based and Institutional Nutrition Interventions in Improving Children's Diet and Health? A Systematic Review. *BMC Public Health* **2017**, *17* (1), 818. <https://doi.org/10.1186/s12889-017-4795-5>.
- (173) Epstein, L. H.; Roemmich, J. N.; Robinson, J. L.; Paluch, R. A.; Winiewicz, D. D.; Fuerch, J. H.; Robinson, T. N. A Randomized Trial of the Effects of Reducing Television Viewing and Computer Use on Body Mass Index in Young Children. *Arch Pediatr Adolesc Med* **2008**, *162* (3), 239–245. <https://doi.org/10.1001/archpediatrics.2007.45>.

- (174) McCabe, P. C.; Altamura, M. Empirically Valid Strategies to Improve Social and Emotional Competence of Preschool Children. *Psychology in the Schools* **2011**, *48* (5), 513–540. <https://doi.org/10.1002/pits.20570>.
- (175) Jones, A.; Armstrong, B.; Weaver, R. G.; Parker, H.; von Klinggraeff, L.; Beets, M. W. Identifying Effective Intervention Strategies to Reduce Children's Screen Time: A Systematic Review and Meta-Analysis. *Int J Behav Nutr Phys Act* **2021**, *18* (1), 126. <https://doi.org/10.1186/s12966-021-01189-6>.
- (176) Wu, L.; Sun, S.; He, Y.; Jiang, B. The Effect of Interventions Targeting Screen Time Reduction: A Systematic Review and Meta-Analysis. *Medicine (Baltimore)* **2016**, *95* (27), e4029. <https://doi.org/10.1097/MD.0000000000004029>.
- (177) Kracht, C. L.; Joseph, E. D.; Staiano, A. E. Video Games, Obesity, and Children. *Curr Obes Rep* **2020**, *9* (1), 1–14. <https://doi.org/10.1007/s13679-020-00368-z>.
- (178) Lu, A. S.; Kharrazi, H.; Gharghabi, F.; Thompson, D. A Systematic Review of Health Videogames on Childhood Obesity Prevention and Intervention. *Games Health J* **2013**, *2* (3), 131–141. <https://doi.org/10.1089/g4h.2013.0025>.
- (179) LeBlanc, A. G.; Chaput, J.-P.; McFarlane, A.; Colley, R. C.; Thivel, D.; Biddle, S. J. H.; Maddison, R.; Leatherdale, S. T.; Tremblay, M. S. Active Video Games and Health Indicators in Children and Youth: A Systematic Review. *PLoS One* **2013**, *8* (6), e65351. <https://doi.org/10.1371/journal.pone.0065351>.
- (180) Yau, K. W.; Tang, T. S.; Görges, M.; Pinkney, S.; Kim, A. D.; Kalia, A.; Amed, S. Effectiveness of Mobile Apps in Promoting Healthy Behavior Changes and Preventing Obesity in Children: Systematic Review. *JMIR Pediatr Parent* **2022**, *5* (1), e34967. <https://doi.org/10.2196/34967>.
- (181) Loo, B. K. G.; Okely, A. D.; Pulungan, A.; Jalaludin, M. Y. Asia-Pacific Consensus Statement on Integrated 24-Hour Activity Guidelines for Children and Adolescents. *Br J Sports Med* **2022**, *56* (10), 539–545. <https://doi.org/10.1136/bjsports-2021-104527>.
- (182) Council on Communications and Media; Hill, D.; Ameenuddin, N.; Reid Chassiakos, Y. (Linda); Cross, C.; Hutchinson, J.; Levine, A.; Boyd, R.; Mendelson, R.; Moreno, M.; Swanson, W. S. Media and Young Minds. *Pediatrics* **2016**, *138* (5), e20162591. <https://doi.org/10.1542/peds.2016-2591>.
- (183) Reid Chassiakos, Y. L.; Radesky, J.; Christakis, D.; Moreno, M. A.; Cross, C.; COUNCIL ON COMMUNICATIONS AND MEDIA. Children and Adolescents and Digital Media. *Pediatrics* **2016**, *138* (5), e20162593. <https://doi.org/10.1542/peds.2016-2593>.
- (184) Healthychildren.org. Family Media Use Plan. https://www.healthychildren.org/English/media/Pages/default.aspx?_ga=2.92989723.748188841.1656407817-944596110.1656407817&_gl=1*rst49*_ga*OTQ0NTk2MTEwLjE2NTY0MDc4MTc.*_ga_FD9D3XZVQQ*MTY1NjQwNzgxNy4xLjAuMTY1NjQwNzgxNy4w (accessed 2022-06-28).
- (185) Canadian Society for Exercise Physiology. *24-Hour Movement Guidelines – Canadian 24-Hour Movement Guidelines*. <https://csepguidelines.ca/> (accessed 2022-06-30).

- (186) Tremblay, M. S.; Carson, V.; Chaput, J.-P.; Connor Gorber, S.; Dinh, T.; Duggan, M.; Faulkner, G.; Gray, C. E.; Gruber, R.; Janson, K.; Janssen, I.; Katzmarzyk, P. T.; Kho, M. E.; Latimer-Cheung, A. E.; LeBlanc, C.; Okely, A. D.; Olds, T.; Pate, R. R.; Phillips, A.; Poitras, V. J.; Rodenburg, S.; Sampson, M.; Saunders, T. J.; Stone, J. A.; Stratton, G.; Weiss, S. K.; Zehr, L. Canadian 24-Hour Movement Guidelines for Children and Youth: An Integration of Physical Activity, Sedentary Behaviour, and Sleep. *Appl Physiol Nutr Metab* **2016**, *41* (6 Suppl 3), S311-327. <https://doi.org/10.1139/apnm-2016-0151>.
- (187) Tremblay, M. S.; Chaput, J.-P.; Adamo, K. B.; Aubert, S.; Barnes, J. D.; Choquette, L.; Duggan, M.; Faulkner, G.; Goldfield, G. S.; Gray, C. E.; Gruber, R.; Janson, K.; Janssen, I.; Janssen, X.; Jaramillo Garcia, A.; Kuzik, N.; LeBlanc, C.; MacLean, J.; Okely, A. D.; Poitras, V. J.; Rayner, M.-E.; Reilly, J. J.; Sampson, M.; Spence, J. C.; Timmons, B. W.; Carson, V. Canadian 24-Hour Movement Guidelines for the Early Years (0–4 Years): An Integration of Physical Activity, Sedentary Behaviour, and Sleep. *BMC Public Health* **2017**, *17* (Suppl 5), 874. <https://doi.org/10.1186/s12889-017-4859-6>.
- (188) Care, A. G. D. of H. and A. *24-hour movement guidelines – birth to 5 years – brochure*. Australian Government Department of Health and Aged Care. <https://www.health.gov.au/resources/publications/24-hour-movement-guidelines-birth-to-5-years-brochure> (accessed 2022-07-04).
- (189) *Physical activity*. Ministry of Health NZ. <https://www.health.govt.nz/our-work/preventative-health-wellness/physical-activity> (accessed 2022-07-18).
- (190) *The health impacts of screen time - a guide for clinicians and parents*. RCPCH. <https://www.rcpch.ac.uk/resources/health-impacts-screen-time-guide-clinicians-parents> (accessed 2022-07-11).
- (191) Viner, R., M. Davie and A. Firth (2019), *The Health Impacts of Screen Time: A Guide for Clinicians and Parents*, RCPCH, London. https://www.rcpch.ac.uk/sites/default/files/2018-12/rcpch_screen_time_guide_-_final.pdf (accessed 2022-07-11).
- (192) United Kingdom Chief Medical Officers' Commentary on 'Screen-Based Activities and Children and Young People's Mental Health and Psychosocial Wellbeing: A Systematic Map of Reviews.' **2019**, 12.
- (193) Davies S.C., Atherton F., Calderwood C., McBride M. U. *Child Safety Online: A practical guide for parents and carers*. Department of Health and Social Care. GOV.UK. <https://www.gov.uk/government/publications/child-safety-online-a-practical-guide-for-parents-and-carers> (accessed 2022-07-12).
- (194) *Keeping under fives safe online*. Childnet. <https://www.childnet.com/help-and-advice/keeping-young-children-safe-online/> (accessed 2022-07-12).
- (195) *The Protection of Children and Youths Welfare and Rights Act - Article Content - Laws & Regulations Database of The Republic of China (Taiwan)*. <https://law.moj.gov.tw/ENG/LawClass/LawAll.aspx?pcode=D0050001> (accessed 2022-07-15).
- (196) *Taiwan Passes Law To Limit Child Screen Use*. Endmyopia®. <https://endmyopia.org/taiwan-passes-law-limit-child-gaming/> (accessed 2022-07-15).

- (197) CNN, J. W. S., for. *Why Taiwan is right to ban iPads for kids*. CNN. https://www.cnn.com/2015/02/03/intl_opinion/taiwan-ipads-kids/index.html (accessed 2022-07-15).
- (198) *Chinese Parents Praise Rule Limiting Video Game Time*. VOA. <https://learningenglish.voanews.com/a/chinese-parents-praise-rule-limiting-video-game-time/6240217.html> (accessed 2022-07-12).
- (199) *State Press and Publication Administration-Notice Publicity-Notice of the State Press and Publication Administration on Further Strict Management to Prevent Minors from Indulging in Online Games*. <https://www.nppa.gov.cn/nppa/contents/279/98792.shtml> (accessed 2022-07-12).
- (200) *Parents in China laud rule limiting video game time for kids*. AP NEWS. <https://apnews.com/article/lifestyle-technology-business-health-games-ba88276e6f9089a3b9bc65fc19cc0880> (accessed 2022-07-12).
- (201) *Chinese newspaper labels gaming 'spiritual opium', names Tencent*. South China Morning Post. <https://www.scmp.com/tech/article/3143609/chinese-newspaper-labels-gaming-spiritual-opium-and-calls-out-tencent-fanning> (accessed 2022-07-12).
- (202) 《未成年人沉迷手机网络游戏现象调研报告》发布 长期沉迷手机网络游戏严重影响未成年人身心健康-公益时报网 The "Investigation Report on the Phenomenon of Minors' Addiction to Mobile Online Games" released long-term addiction to mobile online games seriously affects the physical and mental health of minors. <http://www.gongyishibao.com/html/yanjiubaogao/2021/08/18314.html> (accessed 2022-07-12).
- (203) Zhang, Y.; Tian, S.; Zou, D.; Zhang, H.; Pan, C.-W. Screen Time and Health Issues in Chinese School-Aged Children and Adolescents: A Systematic Review and Meta-Analysis. *BMC Public Health* **2022**, 22 (1), 810. <https://doi.org/10.1186/s12889-022-13155-3>.
- (204) Cai, Y.; Zhu, X.; Wu, X. Overweight, Obesity, and Screen-Time Viewing among Chinese School-Aged Children: National Prevalence Estimates from the 2016 Physical Activity and Fitness in China—The Youth Study. *Journal of Sport and Health Science* **2017**, 6 (4), 404–409. <https://doi.org/10.1016/j.jshs.2017.09.002>.
- (205) *Tencent limits gaming for kids after official media critique*. AP NEWS. <https://apnews.com/article/technology-business-china-media-b48e08c16d0c299a970fda6acd7bcc79> (accessed 2022-07-12).
- (206) Hua, S. *TikTok Maker Caps Screen Time for Youths in China*. WSJ. <https://www.wsj.com/articles/tiktok-maker-caps-screen-time-for-youths-in-china-11632052269> (accessed 2022-07-12).
- (207) Business, C. staff, CNN. *China bans kids from playing online video games during the week*. CNN. <https://www.cnn.com/2021/08/31/tech/china-ban-video-games-minor-intl-hnk/index.html> (accessed 2022-07-12).
- (208) 防沉迷新规首个长假 家长：孩子玩网游少了 看游戏直播多了_凤凰网 New anti-addiction regulations, the first long holiday parent: children play less online games and watch more live games. <https://news.ifeng.com/c/8AEK8kXy01G> (accessed 2022-07-12).
- (209) *China to ban minors from tipping streamers & watching after 10 p.m.* Shacknews. <https://www.shacknews.com/article/130224/china-to-ban-minors-from-tipping-streamers-watching-after-10-pm> (accessed 2022-07-12).

(210) *Family Health Service - Screen Time for Your Kids: Mind the Kind and the Time.*
https://www.fhs.gov.hk/english/health_info/child/30151.html (accessed 2022-08-09).