



WE NEED TOTALK

Screen time in
New Zealand

*MEDIA USE:
An emerging factor in
child and adolescent health*

by Dr Aric Sigman

Report to Family First New Zealand 2015



About the Author

Dr Aric Sigman works independently in health education lecturing at schools, medical schools and to Britain's National Health Service doctors. His paper '*Time for a view on screen time*' was published as the leading article in the British Medical Journals' *Archives of Disease in Childhood*. His latest paper '*Virtually Addicted: why general practice must now confront screen dependency*' is published in Britain's Royal College of General Practitioners' *British Journal of General Practice*. He has published three papers on various aspects of screen time, physiology and health outcomes in *The Biologist*, the journal of the Society of Biology. His biology paper on the role of screen media in the genesis of body dissatisfaction and eating pathology was selected as the '*2012 Scientific Article*' for Britain's Biology A-level exam.

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Executive Summary

New Zealand is blessed with an ideal environment for children and young people to be active and, compared to many other countries, they are. However, this is changing rapidly. Following a global trend, children from infancy are spending greater amounts of time looking at recreational screen media and becoming increasingly sedentary (NIHL 2014).

Discretionary screen time (DST), defined as non-homework and predominantly recreational, is now *the* main waking activity of children – a lifestyle factor as relevant to health and wellbeing as nutrition and physical activity. High discretionary screen time is increasingly considered an independent risk factor, often exhibiting a dose-response relationship with cardiometabolic disease, psychological problems, unfavourable child development outcomes and adult illness and mortality, ultimately placing greater pressure on health services.

Although screen technology may be a beneficial aspect of modern life, there is growing concern from health and development experts about the disproportionate use in many families' lives, particularly the young in New Zealand. The main focus of recent medical concern is the premature use and/or overuse of discretionary screen media in children, as their brains and bodies are not yet fully developed. Interventions therefore emphasise delaying the introduction of screen media to very young children and reducing its excessive discretionary use in all children and adults. As a 'disease prevention objective', government health departments and medical associations are increasingly issuing guidelines for daily discretionary screen time 'consumption'.

Yet parents, children and teachers remain unaware of the medical and developmental risks and the position of medical bodies on DST. And the majority of children and adolescents in New Zealand, including toddlers, continue to significantly exceed medical guidelines. Much of the concern regarding screen media is based on the average number of hours a day children spend watching non-homework screen media, now often referred to as the 'dose' of screen media 'consumed'. Reading books on Kindle or a tablet is not the concern under discussion.

This report provides an overview of some of the evidence which has led health authorities to issue precautionary discretionary screen time guidelines:

- The age at which children start viewing screens and the number of hours watched per day are increasingly linked to negative physiological changes, medical conditions and development outcomes. There appears to be a 'dose-response relationship' with more hours per day linked to a greater likelihood that negative findings will appear, often years later, in the child.
- Excessive discretionary screen time is linked with:
 - Significant sleep disturbances.
 - Unhealthy levels of key chemicals ('biomarkers') associated with illness and premature death.
 - Alterations in stress hormones.
 - Unhealthy body composition, including elevated levels of body fat and obesity.
 - Increased risk of diabetes.
 - A decline in muscular strength and stamina.
 - A reduction in social skills including the ability to read human emotion and cultivate empathy. Brain areas associated with these functions may become under-stimulated and fail to develop appropriately.
- High levels of computer game screen time are associated with subsequent attention problems and impulsiveness.

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Discretionary screen time (DST) is now the main waking activity of children.

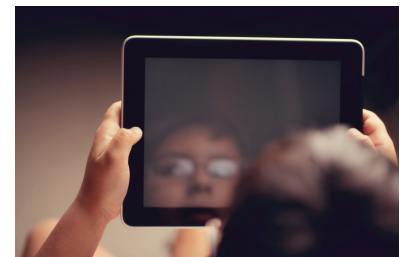
Parents, children and teachers remain unaware of the medical and developmental risks and the position of medical bodies on DST.

Excessive discretionary screen time is linked with significant sleep disturbances.

- Research has identified a 'dose-response' relationship between DST and psychosocial health, where each additional hour viewing increases the likelihood of experiencing socio-emotional problems.
- High levels of social networking have been associated with a decline in mood and increased risk of depression.
- A decline in face-to-face family interaction may compromise relationships and the development of social skills: "No matter how time online is measured and no matter which type of social activity is considered, time spent on the Internet reduces time spent in face-to-face relationships... an hour on the Internet reduces face-to-face time with family by close to twenty-four minutes" (Nie NH et al 2008).
- There appear to be biological processes activated during face-to-face interaction that do not operate sufficiently when communicating through social networking / messaging.
- Although this report is concerned with screen *time*, when one includes screen *content*, the distorting effect on the parental role in imparting their own values and providing boundaries for children could be considerable.
- Background 'passive' media that is not being actively viewed by the child is increasingly associated with developmental risks.
- The term 'addiction' is increasingly used by health professionals to describe the growing number of children engaging in a variety of screen activities in a dependent, problematic manner. It is a problem that is likely to increase among children and adolescents.
- A new generation of studies is finding associations between Internet Addiction Disorder / 'gaming addiction' and abnormal brain tissue and brain function. Although these neurological characteristics may be a precondition rather than a consequence of addiction, child health policy must adhere to the principle of precaution.
- Children are more susceptible to developing a long-term problematic dependency on technology. The age of initiation and level of exposure to, for example, gaming may increase this risk, which may start much earlier than assumed.
- Parental role modelling is a highly important factor: parents who consume high DST have children who are many times more likely to consume high DST.
- Babies and toddlers should learn from play, not screens. 80 per cent of adult brain size growth occurs during a child's first three years, when they may be most vulnerable to the potential effects of screen media. Furthermore, it is imperative that significant periods of time, when infants and toddlers could be learning about the people and things around them and the sensations within them, are not displaced by screen time.
- The amount of DST an older adolescent consumes during their spare private time is negatively associated with academic outcomes.
- The associations between DST and health occur generally beyond two hours per day, yet the average child is exposed to 2 - 4 times this amount. Therefore, reducing total daily DST for children could provide significant advantages for children's health and well-being.

A decline in face-to-face family interaction may compromise relationships and the development of social skills.

High levels of computer game screen time are associated with subsequent attention problems and impulsiveness.



Parental role modelling is a highly important factor.

Babies and toddlers should learn from play, not screens.

- There is good evidence that children's DST can be reduced partly through raising parental awareness and by parents incorporating screen rules into family life:
 - Minimising screen media in children's bedrooms is likely to reduce DST significantly.
 - Involving children in more physical activity is associated with a subsequent reduction in DST.
 - Parental rules on DST have longer-term implications for child health.
 - Mothers who monitor their child's DST early on may have children with a healthier body mass index years later.
- Most importantly, children from an early age must be helped to develop an awareness of discretionary screen time as a health and development issue and to cultivate healthier media consumption habits.
- Health professionals in New Zealand should consider incorporating the topic of media use and health into their dealings with families.
- A lack of action to limit DST is due to the plethora of mixed messages regarding the costs and benefits of DST and a preoccupation with the *content* of screen media without due consideration for the sheer *amount* of habitual consumption. Moreover, there is an implicit and entirely unsubstantiated message that not to expose young children to screen technology puts them at a developmental and educational disadvantage.
- In making personal, family and policy decisions about DST, there is a paucity of readily available objective information. Public discussion of screen media and children is dominated by experts in media studies and 'e-learning'.
- In future, policy makers should, to the best of their ability, excise the influence of the screen-related industries. When considering any evidence on child screen use presented to them, policy makers should be highly vigilant in ensuring a high degree of 'information hygiene' and establish whether screen-related industries have played any part in such research.
- In other areas of child health and development, when considering the potential effects of profound new developments, society instinctively adopts a principle of precaution. Yet, to date, the increasingly excessive levels of child DST have been met with a lack of emphatic health messages. In particular, the absence of any official guidance on DST for the most vulnerable population - babies and all children under age five - is of great concern.
- Of additional concern is the Ministry of Health's statement that it "*has not provided any guidelines regarding the amounts of screen time recommended for those aged 18 and over*" (NZMOH 2014).
- The Ministry of Health should consider DST as a personal health and well-being issue to be formally included in the health education curriculum and taught in the classroom from primary school.

Public health and child wellbeing would benefit significantly if government became more vocal over the issue of excessive DST. Medical bodies and government ministries should formally and vociferously express concern over DST. Moreover, they must concern themselves not with what families and voters are *interested* in hearing but what is in their children's best interests.

New Zealand is in an advantageous position from which to confront excessive DST by adopting preemptive measures and challenging some of the key causes now.

Children from an early age must be helped to develop an awareness of discretionary screen time as a health and development issue.

Policy makers should be highly vigilant in ensuring a high degree of 'information hygiene'.

The increasingly excessive levels of child DST have been met with a lack of emphatic health messages.

Public health and child wellbeing would benefit significantly if government became more vocal over the issue of excessive DST.

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Introduction

Screen time: Big numbers

Researchers in New Zealand writing in the *Journal of Epidemiology and Community Health* stated that “screen time is now the most common waking activity for many children and may even exceed the amount of time spent asleep for some children” (McAnally & Hancox 2014).

And a report by New Zealand’s National Institute for Health Innovation concluded: “The high levels of screen time were concerning and suggest the need to identify and implement effective strategies to reduce screen time in children and youth in New Zealand.” The report found that only 33% of young people aged 10-14 years and 30% aged 15 -19 years met “the recommended screen-time guideline of two hours or less each day” (NIHI 2014).

A major government-funded study by the University of Auckland, *Growing Up in New Zealand*, found that 80% of the two year olds spend an average of 1.5 hours a day in front of a TV screen (Morton et al 2014).

The Ministry of Health reported that almost half of 2 - 4 year olds “watched two or more hours of television each day”, adding that this “does not include other screen time” (NZMOH 2013).

Given that New Zealand is following international trends, it is important to look at DST elsewhere. The UK Government’s Office of Communications (Ofcom) recently issued its annual ‘Media Use and Attitudes report’, which stated: “The average UK 16 -24 year old now spends more time using media or communications than they do sleeping” (Ofcom 2014a).

Ofcom has also measured total screen time for younger age groups:

Total Child Screen Time At Home (UK)

AGES:	HOURS/DAY
3 – 4	3 hrs
5 – 7	4 hrs
8 - 11	4.5 hrs
12 – 15	6.5 hrs

Ofcom: Media consumption (2012)

By the age of seven, a child born in Britain or the US today will have spent nearly one full year of 24 hour days watching recreational screen media. By the age of 18 years, the average European or American child will have spent three years of 24 hour days watching recreational screen media.

At this rate, by the age of 80 years, a child today will have spent almost 20 years watching discretionary screen media - a full quarter of their life.

A pan European study of 25 countries involving the Australian government, ‘Young Children and their Internet Use’, found: “There have been noticeable increases in the internet participation rate of children and young people in all EU countries. However, very young children (0-8) are showing particularly increased patterns of internet use” (Holloway et al 2013).

The Ministry of Health in New Zealand “has never collected information on ‘other screen time’ (e.g. in front of computers or using game consoles). The Ministry does not have and has not received any other research on ‘other screen time’” (NZMOH 2014).

There is little reason to assume that New Zealand will be impervious to these global trends.

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Medical guidelines

Discretionary screen time is no longer merely a cultural issue about how children spend their leisure time, nor is it confined to concern over the appropriate / inappropriate content of what is on the screen. It has now become a medical issue.

The US Department of Health has issued *"recommended limits for screen time"* as one of its national *"health improvement priorities"* and a key *"disease prevention objective"* (USDOH 2014). The British Government's Public Health England recently reported their concern to Parliament over *"increased screen time ... evidence suggests a 'dose-response' relationship, where each additional hour of viewing increases the likelihood of experiencing socio-emotional problems"* and recommends *"rationing children's non-homework screen time"* (PHE 2014). The Canadian Paediatric Society states: *"Too much screen time negatively impacts aspects of cognitive and psychosocial development and may adversely affect body composition"* (CPS 2012).

The Australian Government's Department of Health has issued formal screen time guidelines for all age groups: *"Children younger than two years of age should not spend any time watching television or using other electronic media (DVDs, computer and other electronic games)... no screen-time for children under two ... limit screen-time for two-to five-year-olds ... to less than one hour per day"* (ADOH 2011).

The French government has banned French channels from airing all TV shows – 'educational' and otherwise – aimed at children under three years of age. It has declared: *"Television viewing hurts the development of children under three years old and poses a certain number of risks, encouraging passivity, slow language acquisition, over-excitedness, troubles with sleep and concentration as well as dependence on screens ... even when it involves channels aimed specifically at them"* (High Audiovisual Council 2008). Preschool institutions in Belgium have similar warnings posted on their walls.

Guidance gap?

Yet, New Zealand's youngest children are already significantly exceeding the above recommendations. And the Ministry of Health recently stated: *"The Ministry has not published any specific guidelines on screen time for children under 5 years old."* Regarding their position on screen time for young infants in 'early childhood education', the Ministry states: *"The Ministry has not provided any guidelines regarding the amount of screen time during ECE time to ECEs"* (NZMOH 2014).

Although the Ministry of Health does not appear to have issued screen time guidance for infants and young children from birth until five years as other countries have, the Ministry of Health has stated more generally: *"Guidelines recommend that children and young people (aged 5–18 years) spend no more than two hours in front of television, computers and games consoles per day (out of school time)"* (NZMOH 2012). For those 18 and older: *"The Ministry has not provided any guidelines regarding the amounts of screen time recommended for those aged 18 and over"* (NZMOH 2014).

The Australian Government's Department of Health is more specific: *"Limit screen-time for two-to five-year-olds ... to less than one hour per day"* (ADOH 2011). *"To reduce health risks, children aged 5 - 12 years should ... limit use of electronic media for entertainment (e.g. television, seated electronic games and computer use) to no more than two hours a day - lower levels are associated with reduced health risks"* (ADOH 2014). *"To reduce health risks, young people aged 13 - 17 years should ... limit use of electronic media for entertainment (e.g. television, seated electronic games and computer use) to no more than two hours a day – lower levels are associated with reduced health risks"* (ADOH 2014).

Perhaps the most convincing evidence that children are consuming too much DST and that it's probably not good for their well-being comes from the screen



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NZMOH

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NZMOH

manufacturer Kindle who recently introduced their free built-in parental app to reduce the amount of time children look at Kindle screens: *"Total Screen Time - Limit the total time your child can spend ... Use the slider to adjust total screen time."*

Interestingly, there are no New Zealand Medical Association, Ministry of Health or World Health Organisation warnings for parents to limit the number of books their children read, nor the amount of time parents spend reading to their children. And with good reason - reading books is physiologically and cognitively an entirely different process from viewing most recreational screen media (AAP 2014).

Size matters

There has been a dramatic rise in the number and range of screen devices children have access to accompanied by a convenient reduction in the size of the devices. For example, in Britain today, children by the age of 10 years have regular access to an average of five different screens at home (Jago et al 2011). In addition to the main family television, for example, many very young children have their own bedroom TV along with portable handheld computer game consoles (e.g., Nintendo, Playstation, Xbox), smartphone with games, internet and video, a family computer and a laptop and/or a tablet computer (e.g., iPad). Most devices including Kindle are highly versatile / multifunction, smaller, cheaper and more easily concealed under the bedcovers for late night use.

If parents were to put a refrigerator in their child's bedroom, that child is likely to eat more, and if the fridge contained a choice between broccoli and Goody Goody Gumdrops ice cream, one can be reasonably confident that the broccoli will never leave that fridge. Similarly, if children have several screens in their bedroom, they will consume more DST (USDH 2013) and they're unlikely to spend that screen time on a Kindle reading Shakespeare or The Old Testament.

One in three children in the UK now has their own tablet computer, which has nearly doubled in a year with a sharp increase in tablet ownership among very young children (3 - 4 yrs) (Ofcom 2014b).

Compound media usage

Scientists are now witnessing compound effects. Children and teenagers are spending an increasing amount of time using 'new media' like computers, the internet, iPod videos and video games, without cutting back on the time they spend with 'old' media like television. Instead, because of the amount of time they spend using more than one screen at a time, they're managing to pack increasing amounts of media content into the same amount of time each day, and at younger and younger ages (Ofcom 2014a).

Children routinely engage in two or more forms of screen viewing at the same time, such as TV and laptop (Jago et al 2011). Research on multi-screen viewing in New Zealand finds a growing number of New Zealanders may be involved in "compound media usage". For example, watching a television show on one screen, while on another screen they are looking for extra information about what they are watching – "meshing" – or looking at completely unrelated sites – "stacking" (OneNEWS 2014).

In Britain, the Office of Communication reports: *"They're cramming over 14 hours of media and communications activity into 9 hours 8 minutes each day by multi-tasking, using different media and devices at the same time"* (Ofcom 2014a).

Viewing is starting earlier in life. Nearly one in three American infants have a TV in their bedroom, and almost half of all infants watch TV or DVDs for nearly 2 hours/day (CSM 2011).

A growing number of New Zealanders may be involved in "compound media usage".

Reading books is physiologically and cognitively an entirely different process from viewing most recreational screen media.

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Beyond the statistics, one thing is clear: children have more screens available to them and they now spend *more* time watching TV, playing with computers and surfing the internet at younger ages. The same is true of adults.

Our culture continues to display an ardent enthusiasm for embracing new forms of screen time in expanding areas of our lives and the lives of those closest to us.

For example, there's the iPad-based game to enable our pets to become digital natives too, in the form of "*You vs. Cat, the first (we think) dual-species game for your tablet*" offering "*Gaming Tips for Humans ... The point of You vs. Cat isn't to humiliate your kitty. You want to set your cat up for a positive experience.*" Pet owners are reassured: "*In our experience the bare glass screen on many devices hold up trouble-free to a cat's claws*" (Google 2012).

Dog lovers haven't been forgotten either, as there are "*apps for training your new puppy ... Having a new puppy is a lot like having a baby ... Even if you do end up taking your puppy to obedience school when he's ready, these apps will help you lay the groundwork for a happy, healthy, well-trained dog*" (Techhive 2013).

Costs and benefits

It isn't merely complacency or ignorance that has allowed child screen time (ST) to grow unabated. Parents are bathed in mixed messages about screen technology and their child's well-being.

The advocates of introducing young children to screen media and who play down concerns about the quantity of screen time consumed by children and adolescents contend that it is the 'quality' of what the children consume on the screen – the content – that is critical. It is suggested that provided what the young child sees on the screen is 'educational' and 'age-appropriate', high ST is at worst a waste of time. Moreover, there is an implicit message that not to expose young children to screen technology puts them at a developmental and educational disadvantage.

However, the claim that certain games, DVDs or television programs are 'educational' are claims usually made by the manufacturers and readily accepted by the media. Therefore, it is important to ask: "*Who is making these claims?*", "*Who funds their research?*", and "*Is there a profit to be made by those making such claims?*" Discussion of screen media and children is dominated by experts in media studies and e-learning, yet their expertise is *not* in child health but in *media* and how children interact with it. We must ask ourselves how we would feel if a discussion about child diabetes, cholesterol levels and obesity in New Zealand was conducted by gourmet experts on how children *interact* with a doughnut as opposed to a scientist / cardiologist who studies the effect that the doughnut has on the child's blood chemistry and Body Mass Index.

Research on screen time and child health and development should come from academics associated with child health and not from those whose expertise is media and how children relate to it. Research funds and conferences are often supported by the enormous corporate spending of large technology industries.

Moreover, whether something has any educational value or not, there may be unintended side-effects. A longitudinal study of preschool children entitled '*Evaluating the effect of educational media exposure on aggression in early childhood*' published in the *Journal of Applied Developmental Psychology* concluded: "*Educational media exposure significantly predicted increases in both observed and teacher reported relational aggression across time educational media exposure also significantly predicted increases in parent reported relational aggression across more than a two year period*" (Ostrov et al 2013).

Furthermore, it is often assumed that if children do not 'get used to' screen technology early on, they will in some way be intimidated by it, or be less competent at using it later. In other words they will lose out on the digital future.

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Parents are bathed in mixed messages about screen technology and their child's well-being.

Advocates contend that it is the 'quality' of what the children consume on the screen – the content – that is critical.

Their expertise is not in child health but in media and how children interact with it.

In order to redress this misconception, researchers at Harvard Medical School stated: *"There is no data to substantiate the claim that young children need to learn to become comfortable with screen technology. The fact that children like something, or parents think they do, does not mean that it is educational, or even good for them. Children like candy too"* (Linn & Poussaint 1999).

Research has found that even Rhesus monkeys are comfortable with, and capable of using, the same screen technology that children are exposed to. The charity, Orangutan Outreach, has been conducting trials gauging iPad interaction with their apes, as they believe *"the iPad is a perfect device for orangutans, as they have an innate ability to work with touchscreen technology."* The director has reported: *"It's not really toy-like because they are engaging with them as devices ... it's definitely going in the cognitive direction"* (Orangutan Outreach 2014; BBC Nature 2012).

While the national Smithsonian Institution in Washington DC has announced they're rolling out a new programme 'Apps for Apes' in order *"to offer orangutans the iPad enrichment experience ... Apps for Apes is all about giving orangutans in human care choice over their environment."* Their great ape keeper explained: *"Apps for Apes fits perfectly in this new era of zoo keeping"*. Eventually, the Smithsonian's National Zoo hopes *"to connect its orangutans with those at other zoos using video conferencing platforms"* (Smithsonian 2013). At the same time, the Interspecies Internet describes itself as *"a non-profit organization that facilitates interspecies communication"* (Interspecies Internet 2014).

According to other researchers, like children, *"Rhesus monkeys can be trained ... to complete a variety of computer 'games' or tasks, and the animals readily and freely engage with these tasks for many hours of the day."* And like children, *"A number of studies suggest that the monkeys come to prefer having the computer apparatus available, to not having it available, even when the alternative is free food"* (BBC Nature 2012).

Just because children are interested in doing something does not mean that it is in their best interest to do it.

A recent study in the *American Journal of Primatology* pitting man against ape on a computer game involving a maze found: *"Surprisingly, in the most complex maze category, the humans' performance was less accurate compared to one female chimpanzee"* (Dollins et al 2014).

And so this argument that early intensive electronic media exposure is necessary or else children will be intimidated or lose out appears to be more of a commercial claim, as children and adults can acquire computer skills much later. Moreover, children learn IT in school.

Another point of confusion is a modern emphasis on differentiating between different technology devices and their related activities: watching TV, playing computer games, surfing the internet, instant messaging, smart phones or any other screen exposure. Apps may be considered by some as being more educational, useful and purposeful for children, yet in reality they are merely *"a self-contained program or piece of software designed to fulfill a particular purpose."* And that purpose can mean almost anything. These are only different market sectors. Screen devices today are multifunction and versatile and while adults prefer to distinguish between these various devices and activities, the young brain and body may not. Many of the negative associations with excessive ST presented below may occur whether the child is sitting in front of a computer or a TV and may occur irrespective of the sexual or violent content.

While this trend in introducing screen media in early childhood is gathering strength, a growing body of empirical evidence - most of it from beyond the domains of media studies, education and psychology - is providing a very different account (Hinkley et al 2014; Sigman 2012, 2014). There seems to be a direct conflict between the

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advocates of screen media in early childhood on the one hand, and the warnings arising from studies in paediatric medicine and biology on the other. Specifically, it is the age at which the child starts to watch screen media and the time spent during a child's early years looking at and relating to the medium of the screen that is the central factor (AAP 2011, 2014b). It is the formal aspects of the *medium* itself that is of concern, and not merely the content of young children's experiences with screen media.

This concern is not based on an anti-technology or anti-television philosophy. The concerns are based purely on the *premature* use or *overuse* of screen media in children whose brains and bodies are not yet fully formed. And there are now sound medical reasons for delaying the introduction of screen media to very young children and reducing its excessive discretionary use in all children and adults.

A new generation of research is finding unacceptable associations between excessive ST and negative health and development indices and outcomes in children, adolescents and adults. Although a correlation is not necessarily definitive proof of causation, in other areas of child health and development, when considering the potential effects of profound new developments, our society instinctively adopts a principle of precaution. Yet the opposite principle seems to apply to our children consuming excessive levels of ST.

Those who voice concerns over excessive or premature ST are often told they must 'prove' that such ST can be harmful to children before they are entitled to warn against excessive ST. However, this must be reversed: the burden of 'proof' must now be on those who advocate the status quo to demonstrate that high or premature ST poses no health and development risks to children. Until then, child health policy must adhere to the principle of precaution as a prudent approach to protecting child well being.

Medical Concerns

Why have some governments and medical bodies acted to reduce DST?

The following is not a systematic review but a brief overview of some of the evidence, which has led health authorities to issue precautionary DST guidelines.

Much of the concern regarding screen media is based on the average number of hours a day children spend watching non-homework screen media. This is now often referred to as the 'dose' of screen media 'consumed'. Reading books on Kindle or a tablet is not the concern referred to in this report. The age at which children start viewing screens and the number of hours of DST watched per day are increasingly linked to negative physiological changes, medical conditions and development outcomes. There appears to be a 'dose-response relationship' with more hours per day linked to greater likelihood that negative findings will appear, often years later, in the child.

As a general example, a study of 2000 children published in *Pediatric Research* entitled 'Early childhood television viewing and kindergarten entry readiness' examined children's television exposure at 29 months and their later outcomes when the children reached age 4.5 years. The authors reported: "Conclusion: Increases in total time watching television at 29 months were associated with subsequent decreases in vocabulary and math skills, classroom engagement (which is largely determined by attention skills), victimization by classmates, and physical prowess at kindergarten. These prospective associations, independent of key potential confounders, suggest the need for better parental awareness and compliance with existing viewing recommendations put forth by the American Academy of Pediatrics (AAP)."

The lead author commented: "These are net effects which suggest a developmental course which could ultimately compromise achievement, social relations, physical

The concerns are based purely on the premature use or overuse of screen media in children whose brains and bodies are not yet fully formed. There are now sound medical reasons for delaying the introduction of screen media to very young children.



Our society instinctively adopts a principle of precaution.

The burden of 'proof' must now be to demonstrate that high or premature ST poses no health and development risks to children.

Much of the concern regarding screen media is based on the average number of hours a day children spend watching non-homework screen media.

prowess, and preferences and habits toward a healthy lifestyle" (Pagani et al 2013).

Another example is that of the study 'Early Childhood Electronic Media Use as a Predictor of Poorer Well-being' headed by Deakin University, Melbourne involving over 3600 children in eight European countries and published in the *Journal of the American Medical Association*. The study assessed "6 indicators of well-being" and found: "the likelihood of adverse outcomes in children ranged from a 1.2- to 2.0-fold increase for emotional problems and poorer family functioning for each additional hour of television viewing or e-game/computer use depending on the outcome examined." They concluded: "Higher levels of early childhood electronic media use are associated with children being at risk for poorer outcomes with some indicators of well-being" (Hinkley et al 2014).

Sleep disturbances

Inadequate sleep in childhood is associated with poor mental and physical health, including impaired academic performance, depression, injury, and increased obesity risk (Kelly et al 2013; Cespedes et al 2014).

An increasing number of studies have found that children are getting less sleep than previous generations and are experiencing more sleeping difficulties (Matricciani et al 2012).

Among many factors that influence children's sleep, screen time and the presence of a screen in the bedroom are increasingly prevalent elements in young children's lives.

In trying to explain the "declining sleep duration of young people" in New Zealand, the National Institute for Health Innovation, University of Auckland studied a nationally representative sample of over two thousand 5 - 18 year olds. They categorised "the top 20 ... presleep activities" engaged in by children finding that: "Screen sedentary time dominated the presleep period in this sample and was associated with a later sleep onset." The opposite was true of children who spent "greater time in nonscreen sedentary activities and self-care", including reading. The researchers recommend: "Interventions to reduce screen-based behaviours in the presleep period may promote earlier sleep onset and ultimately improved sleep duration in young people" (Foley et al 2013).

A study of 'Adolescent Sleep Patterns and Night-Time Technology Use' led by a team at Australia's National Health and Medical Research Council reported "a dose-response relationship ... Use of computers, cell-phones and televisions at higher doses was associated with delayed sleep / wake schedules and wake lag, potentially impairing health and educational outcomes" (Gamble et al 2014).

Recent research in different countries has found a significant relationship between DST, including screen use away from the bedroom, and sleeping difficulties in different age groups ranging from infants to adults. A longitudinal study of 10 - 11 year old children in Finland found that computer use and television viewing predicted significantly shorter sleep duration and later bedtimes, and unfavourable changes in sleep duration and bedtimes on school days and weekends. Among boys, screens in the bedroom predicted poorer sleep habits and irregularity of sleep habits. Interestingly, the actual DST for children was relatively low: "Children used a computer for one hour per day and watched TV over one hour a day" (Nuutinen et al 2013).

A study on 11 - 13 yr olds in Britain examined the associations between bedtime use of a range of "six specific technologies" and adolescent sleep quantity, sleep quality, and parasomnias. The conclusion was: "Frequent weekday technology use at bedtime was associated with significant adverse effects on multiple sleep parameters" (Arora et al 2014).

Another study of 5 - 6 year olds found that both active TV viewing and background 'passive' TV exposure was related to shorter sleep duration, sleeping disorders, and

Among boys, screens in the bedroom predicted poorer sleep habits and irregularity of sleep habits.

Higher levels of early childhood electronic media use are associated with children being at risk for poorer outcomes with some indicators of well-being.

Screen sedentary time dominated the presleep period in this sample and was associated with a later sleep onset.



overall sleep disturbances. Moreover, passive exposure to TV of more than two hours per day was strongly related to sleep disturbances. TV viewing and particularly passive TV exposure *"significantly increase the risk of sleeping difficulties ... parents should control the quantity of TV viewing and ... limit children's exposure to passive TV"* (Paavonen et al 2006).

Pre-sleep screen use is believed to affect sleep patterns in three ways: time displacement, the suppression of *melatonin* the sleep-promoting hormone, and cognitive arousal. Time displacement of sleep has been shown to increase when a media device, such as a television, is present in the bedroom (Foley et al 2013).

The American Academy of Pediatrics has recently advised *"Avoid using screens right before bedtime. The light from the screen can disrupt a child's ability to fall asleep"* (AAP 2014b). The blue light emitted by screens (see below "Blue Light") may suppress melatonin concentrations in children, which disrupts the brain's sleep-wake cycle (circadian rhythm) and delays sleep onset (Lockley et al 2003).

Melatonin is produced in the brain. As it grows dark melatonin levels rise and help facilitate sleep. Researchers have reported that when children aged 6 - 12 were deprived of their TV sets, computers and video games, their melatonin production increased by an average 30%. Exposure to screen media was associated with lower urinary melatonin levels, particularly affecting younger children at a stage of pubertal development when important changes in melatonin's role take place. The lead author speculated that girls are reaching initial stages of puberty earlier than in the 1950s. One reason is due to their average increase in body fat, but another may be due to reduced levels of melatonin. Animal studies have shown that low melatonin levels have an important role in promoting an early onset of puberty (Salti et al 2006).

Finally, 'thriller' or action-oriented electronic games may stimulate children through heightened processes, such as fear or excitement, which may result in physical reactions such as increased heart rate and perspiration (Foley et al 2013). Moreover, if children regularly engage in presleep entertainment screen activities in bed, there is the possibility that they are conditioning their brains and minds to associate their bedroom with an exciting entertainment zone as opposed to a room to relax and sleep in.

The above factors have potentially additive, negative effects on the viewer's sleep duration.

The consequences of pre-sleep media are now being examined. The study *'Single night video-game use leads to sleep loss and attention deficits in older adolescents'* published in the *Journal of Adolescence* concluded: *"In order to minimise negative consequences of video-game playing, video-games should be used in moderation, avoiding use close to the sleep period, to obviate detriments to sleep and performance"* (Wolfe et al 2014).

Blue light

Almost all screen devices emit blue light. Harvard Medical School published a statement on the matter: *"While light of any kind can suppress the secretion of melatonin, blue light does so more powerfully ... Blue wavelengths - which are beneficial during daylight hours because they boost attention, reaction times, and mood - seem to be the most disruptive at night ... Light at night is bad for your health, and exposure to blue light ... may be especially so ... Avoid looking at bright screens beginning two to three hours before bed"* (Harvard Medical School 2012).

There are now special lenses, clip-on lenses and glasses which purport to filter out blue light, along with apps that purport to adjust the amount of blue light emitted by screens at night. The electronic book device Kindle Paper White is thought to emit less blue light and to shine less light directly into the eyes.



Avoid using screens right before bedtime. The light from the screen can disrupt a child's ability to fall asleep.

The American Academy of Pediatrics

Blue wavelengths – which are beneficial during daylight hours because they boost attention, reaction times, and mood – seem to be the most disruptive at night.

Screen time accounted for one third of the 90 minutes before sleep onset in New Zealand young people aged 5 to 18 years.

National Institute for Health Innovation, University of Auckland

Finally, a recent systematic review of the scientific literature concluded: *"Youth should be advised to limit or reduce screen time exposure, especially before or during bedtime hours, to minimise any harmful effects of screen time on sleep and well-being"* (Hale & Guan 2014). Yet the study above by the National Institute for Health Innovation, University of Auckland found that *"screen time accounted for one third of the 90 minutes before sleep onset in New Zealand young people aged 5 to 18 years"* (Foley et al 2013).

New research in the journal *Sleep Disorders* included all screen time - academic screen use in school and for homework - and also found a significant link with sleep disruption: *"Conclusion: The intensive ICT use was associated with poorer quality of sleep indicated by physiological measures among children and adolescents. Knowing the crucial role of healthy sleep in this age, the results are reason for concern. ...High amount of ICT use by children and adolescents may destroy good sleep pattern"* (Ononogbu et al 2014).

Body fat

It's hardly surprising that spending hours a day sitting inert rather than running about does not make children fit. But research increasingly identifies screen viewing as an independent and significant factor in child obesity. In fact, DST may lead to more body fat than other sedentary activities such as reading.

A research team at the University of South Australia assessed the weight and DST of 2200 children and published the study *'Screen time is more strongly associated than physical activity with overweight and obesity in 9- to 16-year-old Australians'* in the medical journal *Acta Paediatrica* (Maher et al 2012).

A European study involving preschool children on DST and body fat found that: *"Each extra hour of watching TV was associated with an extra 1 kg of body fat ... Preschool children who watch more TV are fatter and are less active ... the relation between TV viewing and fatness is not mediated by physical activity..."* (Jackson et al 2009). Another study involving New Zealand children monitored DST and body fat at ages 1, 3, 5 and finally at age seven and found *"hours of television viewing to be independently associated with Percentage of Body Fat at 7 years ... interventions need to start early [preschool]"* (Blair et al 2007).

Screens in children's bedrooms is now a significant issue in child and adolescent body fat (adiposity). The *Journal American Medical Association: Pediatrics* recently published a study *'Association of a Television in the Bedroom With Increased Adiposity Gain'* which found: *"Having a bedroom television is associated with weight gain beyond the effect of television viewing time. ... the effect attributable to this risk factor among US children and adolescents is excess weight of 8.7 million kg [of body fat] per year"* (Gilbert-Diamond et al 2014).

Examining the role of parental genes vs. screens in explaining child body fat (adiposity) epidemiologists reporting in *BMC Pediatrics* concluded: *"For both parent and offspring, adiposity was greater with greater total screen time. Conclusions: ... parental/offspring correlations for both fatness and screen time suggest both a genetic and environmental influence"* (Steffen et al 2013).

There is evidence that the effects of excessive viewing on children's body composition in the very young may appear years later, as suggested by the study *'Early Childhood Television Viewing Predicts Explosive Leg Strength and Waist Circumference by Middle Childhood'* (Fitzpatrick et al 2012).

Obesogenic mechanisms

But how does discretionary screen time actually increase body fat? DST is clearly associated with unhealthy dietary behaviours in children, adolescents and adults (Pearson & Biddle 2011). However, in addition to the influence of food advertising,

Research increasingly identifies screen viewing as an independent and significant factor in child obesity.



Preschool children who watch more TV are fatter and are less active.

Having a bedroom television is associated with weight gain beyond the effect of television viewing time.

studies of children's eating behaviour in direct response to screen viewing suggest it can act as a distraction away from vital satiation food cues toward non-food cues (the screen), thereby disrupting the development of satiation to food and, therefore, increasing food intake while children are viewing. The brain may be monitoring external, non-food cues - the television screen - rather than internal food cues telling us that we have eaten enough. Experiments have found that when distracted in this way we continue to salivate in response to more and more food when normally we would not. A study concluded that watching television can disrupt the natural link between appetite and eating (Temple et al 2007).

A US study found that even children who watched a below average amount of television (less than three hours a day for an average of 2.7 days a week) ate roughly the equivalent of an extra meal a day more than those who watched none (Stroebele & de Castro 2004).

How engaging the things are that we are viewing on the screen also appears to influence how much we eat according to the study '*The better the story, the bigger the serving: narrative transportation increases snacking during screen time*' published in the *International Journal of Behavioral Nutrition and Physical Activity* (Lyons et al 2013).

And the effects on increased appetite may continue long after the screen is turned off and viewing stops because the screen engagement may prevent our brains from subconsciously memorising what we're currently eating - potentially a key aspect of appetite regulation. Eating a meal while viewing screens is thought to disrupt the encoding and memory formation of the meal. Impaired memory for recent eating may increase food intake hours after viewing stops. A study in the journal *Appetite* of females in late adolescence found that the "*effects of television watching on food intake extend beyond the time of television watching to affect subsequent consumption ... [TV] increases afternoon snack intake of young women*" (Higgs & Woodward 2009; Higgs & Donohoe 2011).

In '*Video game playing increases food intake in adolescents*', scientists reported that video game playing was found to significantly increase food intake in adolescents immediately after playing "*and was not compensated for during the rest of the day.*" One hour of playing a video game resulted in an extra daily calorie surplus of 163 kcal, a rate of 60,000 kcal/year, which could help manufacture almost 8 kg of body fat per year (Chaput et al 2011). And violent video games may have a more pronounced effect on self-control when one is faced with junk food (chocolate) than nonviolent games. A study published in *Social Psychological and Personality Science* reported: "*Results showed that violent video games decreased self-control*" (Gabbiadini et al 2013).

These findings occur at a time when in the UK, for example, 68 per cent of evening meals are eaten in front of the television and many children eat while looking at one of many possible screen devices.

The above information may offer also solutions. For example, researchers at the State University of New York studied the effects of screen-watching on the weight of 70 four to seven year olds in the fattest 25 per cent of the population. The children were divided into two groups: one had its TV and computer viewing reduced by half; the other did not. After two years, there had been a significant reduction in the body mass index (BMI) of those who had halved their screen-viewing and relatively little in those who hadn't. The academics concluded: "*Reducing television viewing and computer use may have an important role in preventing obesity and in lowering BMI in young children*", adding that putting a television in a child's bedroom might increase the risk of obesity more than televisions in family spaces (Epstein et al 2008).

The above findings may have significant public health implications. Children 9 - 12 years old with a high BMI are more likely to have high blood pressure, cholesterol and blood insulin levels by adolescence (Lawlor et al 2010). Even marginally elevated BMI in adolescence constitutes a substantial risk factor for early occurrence of angiography-proven coronary heart disease (Tirosh et al 2011).

Many children eat while looking at one of many possible screen devices.

DST is clearly associated with unhealthy dietary behaviours in children, adolescents and adults.



Reducing television viewing and computer use may have an important role in preventing obesity and in lowering BMI in young children.

The multidisciplinary pan-European EU ToyBox study consortium has in its 'Evidence-based recommendations for the development of obesity prevention programs targeted at preschool children' called for European-wide "Limitation of leisure screen time to <1 hours/day (or the amount of time recommended by appropriate national guidelines, if less than 1 hour/day)" (Summerbell et al 2012).

Mortality and morbidity

Numerous well-designed longitudinal studies have found a highly significant dose-response association between DST and risk of type 2 diabetes, cardiovascular disease (CVD) and all-cause mortality among adults, with DST identified as an independent risk factor with "biological plausibility" (Grøntved & Hu 2011; Wijndaele et al 2011; Mathews et al 2012).

In the study of 'Television Viewing and Incident Cardiovascular Disease', epidemiologists at Britain's Medical Research Council and Institute of Public Health, University of Cambridge suspected that watching high levels of television "may result in detrimental associations which differ in effect size from those caused by sitting per se" and found that every one hour/day increase in television viewing was associated with a 6% increased hazard for total fatal or non-fatal cardiovascular disease, and an 8% increased hazard for coronary heart disease, independent of other explanatory factors including gender, age, education, smoking, alcohol, medication, diabetes status, preexisting cardiovascular disease, family history, sleep duration and physical activity. They concluded: "Television viewing independently contributes to increased CVD risk" (Wijndaele et al 2011).

At the same time, other studies such as 'Screen-Based Entertainment Time, All-Cause Mortality, and Cardiovascular Events' report that for participants engaging in four hours per day of recreational ST relative to less than two hours per day, there was a 48% increased hazard for all-cause mortality, and a 125% increased hazard for CVD events of which 25% was explained by cardiometabolic biomarkers - unhealthy levels of key chemicals associated with illness and premature death (Stamatakis et al 2011).

A 14-year study of 135,000 multiethnic adults involving 19,143 deaths was recently published in the *International Journal of Epidemiology* examining the 'Association between various sedentary behaviours and all-cause, cardiovascular disease and cancer mortality'. The study found that "leisure time spent sitting, particularly watching television, may increase overall and cardiovascular mortality. Sitting at work or during transportation was not related to mortality" (Kim et al 2013).

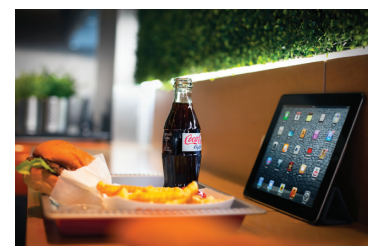
New research in the *Journal of Epidemiology and Community Health* reports that: "Frequent TV viewing during adolescence and early adulthood influenced cardio-metabolic risk in mid-adulthood in a dose-dependent manner, corresponding to a cumulative risk life course model." The researchers highlighted the specific vulnerability of children's bodies in this process. "Additionally, TV viewing in adolescence may constitute a sensitive period for the metabolic syndrome in mid-adulthood" (Wennberg et al 2014).

Biochemical analyses of blood samples are finding that increased DST, particularly watching television, is increasingly linked with unhealthy levels of key chemicals ('biomarkers') associated with illness and premature death. Although the chemical terms below may not be familiar to most readers, the general premise is clear. Moreover, it is important to understand that issues surrounding discretionary screen time are not merely cultural, social and behavioural.

Cardiometabolic biomarkers of disease

In children and adults, DST has been found to have an unfavourable dose-response association with a range of biomarkers for cardiovascular disease, type 2 diabetes and metabolic syndrome (MetS) including compounds such as LDL/HDL/total cholesterol, triglyceride, fibrinogen, C-reactive protein, and systolic/diastolic blood

Leisure time spent sitting, particularly watching television, may increase overall and cardiovascular mortality.



Screen time is not merely 'sedentary behaviour'.

pressure (BP) (Wijndaele et al 2011; Pinto Pereira et al 2012).

A study involving the University of Sydney and the New South Wales Department of Health entitled 'Screen Time and Metabolic Risk Factors Among Adolescents' found that adolescent boys who consume more than two hours per day of discretionary ST were more than twice as likely to have abnormal levels of insulin and homeostatic model assessment of insulin resistance (HOMA-IR), suggesting an increased risk of insulin resistance (Hardy et al 2010).



Another study involving 13–18.5 year olds in five Spanish cities found those watching more than three hours of TV per day had “*significantly less favourable levels*” of HDL-cholesterol, glucose, apolipoprotein A1 and overall CVD risk scores (Martinez-Gomez et al 2010).

A study of 3305 multiethnic Asian adults tried to examine whether there is something specific about DST that explains its link with diseases and premature death, proposing: “*It is possible that TV viewing, as an epidemiologic construct, comprises more than sedentary behaviour.*” Television ST was measured as including other recreational screen activities such as “*playing computer / handheld video games on the television screen.*” The results were that: “*Longer television screen time was significantly associated with higher systolic blood pressure, total cholesterol, triglycerides, C reactive protein, HOMA-IR, and lower adiponectin after adjustment for potential socio-demographic and lifestyle confounders ... No association was observed between computer / reading time and worse levels of cardio-metabolic biomarkers*” (Nang et al 2013).

Screen time is not merely 'sedentary behaviour'

The association between DST and health risk may not be as simple as DST merely being a 'lazy couch potato' sedentary behaviour. First, sedentary behaviour as a risk factor is distinct from too little moderate-to-vigorous physical activity (MVPA), with the two possibly being separate constructs involving different metabolic pathways contributing to disease (Hardy et al 2010; Martinez-Gomez et al 2010; Carson & Janssen 2011; Inoue et al 2012). Prolonged DST has been found to elevate health risk independent of the level of MVPA people routinely engage in (Inoue et al 2012). An analysis of the ongoing *US National Institutes of Health Diet and Health Study* observed that even among people with high levels of MVPA, high amounts of television viewing remain associated with a 47% increased risk for all-cause mortality and a 100% increased risk for cardiovascular mortality (Mathews et al 2012). Another study of body composition and abdominal obesity in children across 10 European cities has recently concluded that physical activity does not remove the obesity risk associated with high DST (Rey-Lopez et al 2012).

A longitudinal study 'Time spent watching television is associated with arterial stiffness in young adults' at the Maastricht University Medical Centre in the Netherlands found hardening of the arteries in young people with higher TV viewing time “*independent of potential confounders, such as vigorous intensity HPA [habitual physical exercise] and other lifestyle risk factors*” (van de Laar 2014).

Moreover, children's DST may be somewhat distinct from other forms of sedentary behaviour in its influence on biological risk factors for disease. For example, examining a range of sedentary behaviours, screen activities and blood pressure (BP) in young adolescents, Gopinath et al (2011) reported a dose-response relationship: “*Each hour per day spent in screen time, watching TV and playing video games was associated with a significant increase in diastolic BP By contrast, each hour per day spent reading was associated with a decrease...*” In prepubescent children, TV viewing and total ST, but not computer use, have been found to be associated with both increased systolic and diastolic BP, while painting or sitting were not (Martinez-Gomez et al 2009). Additionally, different screen activities may have differing independent associations with biomarkers and chronic disease risk in youth (Goldfield et al 2011; Carson et al 2011; Martinez-Gomez et al 2009).

Each hour per day spent in screen time, watching TV and playing video games was associated with a significant increase in diastolic BP....By contrast, each hour per day spent reading was associated with a decrease...

The results suggest a stress response as a consequence of a long period of ICT use.

A cross-sectional study of a large sample of overweight and obese adolescents concluded that time spent playing seated video games was the only type of ST associated with increased BP and total cholesterol/HDL ratio (Goldfield et al 2011).

Carson and Janssen (2011) found in a representative population of 6 – 19 year olds that time spent watching TV was predictive of a higher score of cardio-metabolic risk, but recreational computer time was not, while in prepubertal children, Martinez-Gomez et al (2009) found that TV viewing but not computer time was associated with increased BP. In 5 - 6 year olds, others found “no convincing evidence for an association between TV or PC time and cardiometabolic function” (Chinapaw et al 2014).

Studies of the Hypothalamic Pituitary-Adrenal (HPA) stress-regulation system and DST shed further light on underlying mechanisms, which may explain some of the links between ST and cardiometabolic disease. A Finnish research team studying ST and the stress hormone cortisol suggest that: “Interactions [with screen devices] may elicit strong emotional responses, such as enthusiasm, fear, and surprise, affect the individual’s arousal level, and demand voluntary, directed attention and cognitive processing. Although adolescents experience the different ICT activities mainly positively, long-lasting use of ICT may, however, result in more negative consequences.” They found that school-aged children who had used Information and Communication Technology (ICT) equipment for an average of three hours the preceding day showed a significantly reduced cortisol increase one hour after waking compared with children who had not used ICT at all, or for less than one hour. “The results suggest a stress response as a consequence of a long period of ICT use... [which] can persist over night and have an impact on the regulation of HPA-activity even the next morning.” They suggest that child ST day after day may “predispose some adolescents to the development of allostatic load [wear and tear on the body]. It seems possible that long hours of ICT use day after day might work like a naturally occurring stressor.” There is already concern that even HPA changes within the normal range may be subtle early indicators of, and contributors to, unfavourable physical health outcomes in adolescence and adulthood (Wallenius et al 2010).

Despite the mixed findings in the area of DST and cardiometabolic health risk, health authorities are advising against allowing children to engage in high levels of DST (NZMOH 2013a; ADOH 2014; USDH 2014).

Attention and brain function

DST is associated in a dose-response manner with subsequent attention problems in children and young adults. A longitudinal study of 2623 children reported that children who watched television at ages one and three years had a significantly increased risk of developing attentional problems by the time they were seven years old. For every hour of television a child watched per day, there was a 9% increase in subsequent attentional problems consistent with a diagnosis of ADHD (Christakis et al 2004).

A longer-term dose-response association has been found between television viewing at the ages of five and 11 years, and subsequent attention problems in adolescence independent of early attention problems and other confounding factors (Landhuis et al 2007). Similar associations have been reported in 14 – 22 year olds, and in a study of 8 - 24 year olds published in *Pediatrics*, the researchers concluded: “Viewing television and playing video games each are associated with increased subsequent attention problems in childhood... late adolescence and early adulthood...” (Johnson et al 2007; Swing et al 2010).

A study of 3,034 children and adolescents entitled ‘Video Game Playing, Attention Problems, and Impulsiveness: Evidence of Bidirectional Causality’ concluded: “Those who spend more time playing video games subsequently have more attention problems, even when earlier attention problems, sex, age, race, and socioeconomic status are statistically controlled. Violent content may have a unique effect on attention problems and impulsiveness, but total time spent with video games appears to be a more consistent predictor” (Gentile et al 2012).

For every hour of television a child watched per day, there was a 9% increase in subsequent attentional problems consistent with a diagnosis of ADHD.



High levels of computer game screen time may reduce a child’s ability to pay sustained attention.

The neurotransmitter dopamine is central to the ability to pay attention and implicated in attention problems. It is produced in response to screen novelty.

There is also the issue of the *type* of attention that may be affected, in particular *sustained* attention. The study 'A negative association between video game experience and proactive cognitive control' published in *Psychophysiology* reported: "In conclusion, our results may serve to constrain the claims of some scholars, game manufacturers, and journalists who have suggested that playing action video games 'improves attention'... high levels of video game experience may be associated with a reduction in the efficiency of processes supporting proactive cognitive control that allow one to maintain goal-directed information processing in contexts that do not naturally hold one's attention" (Bailey et al 2010).

In other words, high levels of computer game screen time may reduce a child's ability to pay *sustained* attention - a fundamental skill to *maintain* attention over long periods - which is often necessary during tedious activity. Although with video gaming a child's ability to focus on an avatar or screen object may in the short term show an improvement, in the long run the type of attention required to reflect and understand something at a deeper level could suffer. Cyber-entertainment may be focusing on breadth at the expense of depth.

The increasing practice among New Zealanders mentioned earlier of 'compound media usage' involving multitasking through 'stacking' and 'meshing' may be encouraging the switching of attention between multiple sources of information, but this may have unintended consequences for other abilities and even on brain structure. The recent study 'Higher Media Multi-Tasking Activity Is Associated with Smaller Gray-Matter Density in the Anterior Cingulate Cortex [ACC] ...' "investigated relationships between media multitasking activity and brain structure. Research has demonstrated that brain structure can be altered upon prolonged exposure to novel environments and experience ... In conclusion, individuals who engaged in more media multitasking activity had smaller gray matter volumes [size] in the ACC. This could also possibly explain the poorer cognitive control performance and negative socio-emotional outcomes associated with increased media-multitasking" (Loh & Kanai 2014).

In addition to screen time, screen 'speed' - the pace of editing and degree of novelty within screen material - is increasingly thought to be an important factor in the above findings. A controlled experiment published in *Pediatrics* "found that 9 minutes of viewing a popular fast-paced fantastical television show immediately impaired 4-year-olds' EF [executive function], a result about which parents of young children should be aware" (Lillard & Peterson 2011).

Psychosocial Health

DST is associated with measures of child mental and social well-being.

The British Government's Public Health England recently reported their concern to Parliament over "increased screen time ... evidence suggests a 'dose-response' relationship, where each additional hour of viewing increases the likelihood of experiencing socio-emotional problems" and recommends "rationing children's non-homework screen time" (PHE 2014).

A long-term study by researchers at the Dunedin School of Medicine and University of Otago followed children from birth to age 26 and reported that: "Excessive television appears to have long-term psychosocial consequences." The researchers noted that: "Excessive television viewing during childhood and adolescence was associated with objective and subjective measures of antisocial behaviour in adulthood. These associations were not explained by preexisting antisocial tendencies or other potential confounders ... the findings are consistent with a causal association" (Roberts et al 2013).

Individuals who engaged in more media multitasking activity had smaller gray matter volumes [size] in the ACC.



Excessive television viewing during childhood and adolescence was associated with objective and subjective measures of antisocial behaviour in adulthood.

The sheer amount of consumption is the key factor.

Impulsiveness and moral disengagement

A study of video game playing, attention problems, and impulsiveness in children and adolescents published in *Social Psychological and Personality Science* found that: *"Total video game exposure is a more robust predictor of attention problems and impulsiveness than violent gaming ... Violent content may have a unique effect on attention problems and impulsiveness, but total time spent with video games appears to be a more consistent predictor"* (Gentile et al 2012). Again, the sheer amount of consumption is the key factor.

However, content does appear to have an influence. The study *'Interactive Effect of Moral Disengagement and Violent Video Games on Self-Control, Cheating, and Aggression'* proposed that: *"Violent video games glorify and reward immoral behaviors (e.g., murder, assault, rape, robbery, arson, motor vehicle theft). ... we predicted that violent games would increase multiple immoral behaviors (i.e., lack of self-control, cheating, aggression)."*

Adolescents were asked to play either a violent game (*Grand Theft Auto*) or a nonviolent game and then tested after the game. The predictions of the researchers seemed correct: *"Results showed that violent video games decreased self-control and increased cheating and aggression, especially for people high in moral disengagement"* (Gabbiadini et al 2013).

'Facebook depression'

The American Academy of Pediatrics (AAP) has published a report on *'The Impact of Social Media on Children, Adolescents and Families'* which contains a section entitled: *"Facebook Depression ... defined as depression that develops when preteens and teens spend a great deal of time on social media sites, such as Facebook, and then begin to exhibit classic symptoms of depression"* (Schurgin O'Keeffe & Clarke-Pearson 2011).

The AAP report is supported by further research, for example the study *'Facebook Use Predicts Declines in Subjective Well-Being in Young Adults'* which assessed *"how people feel moment-to-moment and how satisfied they are with their lives"* over a two-week period. The results of the experiment were unlikely to have had a positive impact on the mood of Facebook shareholders. The lead researcher commented: *"The more you used Facebook, the more your mood dropped."* The study concluded: *"On the surface, Facebook provides an invaluable resource for fulfilling the basic human need for social connection. Rather than enhancing well-being, however, these findings suggest that Facebook may undermine it."* Interestingly, they also found that: *"Interacting with other people 'directly' defined as face-to-face or phone interactions ... led people to feel better over time"* (Kross et al 2013).

A British study found that children who spent more than two hours/day watching television or using a computer *"were at [60%] increased risk of high levels of psychological difficulties and this risk increased if the children also failed to meet physical activity guidelines.... Both television viewing and computer use are important independent targets for intervention for optimal well-being for children, irrespective of levels of moderate / vigorous physical activity (MVPA) or overall sedentary time"* (Page et al 2011).

An analysis of 9 - 10 year old girls conducted by the Department of Public Health Sciences, University of North Carolina found ST to be *"negatively associated with self-esteem"* (Racine et al 2011). In the study *'Media use, face-to-face communication, media multitasking, and social well-being among 8- to 12- year-old girls'*, the survey of 3461 North American girls found a significant association between ST as well as measures of media multitasking and negative psychosocial well-being. Conversely, face-to-face communication was strongly associated with positive psychosocial well-being (Pea et al 2012). A study of Japanese children aged 5 - 14 years reports ST had a strong association with negative feeling upon awakening and recommends guidelines for child ST as a preventive measure (Kondo et al 2012).

The more you used Facebook, the more your mood dropped.

Results showed that violent video games decreased self-control and increased cheating and aggression, especially for people high in moral disengagement.



Interacting with other people 'directly' defined as face-to-face or phone interactions ... led people to feel better over time.

Adjusting for pre-existing individual and family factors, a prospective longitudinal study of 1314 Canadian children published in the *Archives of Pediatric and Adolescent Medicine* found significant negative associations between ST at 29 and 53 months of age, and psychosocial well-being at age 10 years. Each one hour increase in early childhood exposure corresponded to a 7% decrease in classroom engagement and 10% increase in victimisation in middle childhood. Researchers reported: *"Higher levels of early childhood television exposure predicted greater chances of peer rejection experiences such as being teased, assaulted, or insulted by other students ... our results suggest that reduced time for critical social interactions in early childhood owing to displaced time spent watching television may present later specific risks of developing inadequate social skills"* (Pagani et al 2010).



In understanding the above associations, several mechanisms have been proposed. Humans require a certain amount of 'co-presence' - regular eye-to-eye contact for optimal physical and mental health (Holt-Lunstad et al 2010). Moreover, the fundamental ability to relate to others is dependent on social and emotional skills that are learnt through *regular* social interaction.

Face-to-face conversations confer linguistic skills, along with the ability to have conversations - to know when and how to listen and contribute. This learning process is highly technical and time consuming (Abu-Akel 2002). For example, during face-to-face interaction, in addition to hearing a voice and accompanying facial expressions of the speaker's face, the speech sounds produce tiny bursts of aspiration - air pressure which hit the child's skin - tactile information contributing to auditory perception (Gick & Derrick 2009).

Emotional development involving key bonding hormones is also enhanced through real-time voice conversation as opposed to instant-messaging. The study *'Instant messages vs. speech: hormones and why we still need to hear each other'* published in the journal *Evolution and Human Behavior* monitored girls' stress and bonding hormones (cortisol vs. oxytocin) when they were put under emotional stress. The children could then either instant message their mothers, speak on the telephone to their mothers, speak in person with their mothers, or have no interaction with their parents at all. The researchers reported: *"We discovered that unlike children interacting with their mothers in person or over the phone, girls who instant messaged did not release oxytocin; instead, these participants showed levels of salivary cortisol as high as control subjects who did not interact with their parents at all"* (Seltzer et al 2012).

Higher levels of early childhood television exposure predicted greater chances of peer rejection experiences such as being teased, assaulted, or insulted by other students.

DST, brain development and social skills

The development of empathy and compassion requiring subtle skills of reading the nonverbal nuances of others' emotions involve similar learning processes, which appear to have a neurological basis. For example, the brain's insular cortex has been identified as a key brain mechanism involved in experiencing the emotional states of others and is thought to underlie egalitarian behaviour in humans (Dawes et al 2012).

Feeling empathy for a friend's emotional suffering activates *"affective pain regions"* in the brain associated with having firsthand experience of the same suffering (Meyer et al 2012). The learning effects of routinely experiencing such social emotions are reflected neurologically. The *"deliberate cultivation of compassion"* through *"compassion training"* for empathic responses to other people is associated with changes in *"functional neuroplasticity"* in the brain (Klimecki et al 2012).

At the same time, researchers conducting functional magnetic resonance imaging (fMRI) research have expressed concern that when using the internet, for example, the areas of the brain associated with empathy showed virtually no increase in stimulation, concluding: *"Young people are growing up immersed in this technology and their brains are more malleable, more plastic and changing than with older brains ... As the brain evolves and shifts its focus towards new technological skills, it drifts away from fundamental social skills"* (Immordino-Yang et al 2009; Small 2008).

Humans require a certain amount of 'co-presence' - regular eye-to-eye contact for optimal physical and mental health.

Mirror neurons

A child's brain is also believed to have multiple networks of brain cells - 'mirror neuron systems' - that specialise in carrying out and understanding not just the actions of other children, but their intentions - the social meaning of their behaviour and their emotions. People who rank high on a scale measuring empathy have particularly active mirror neuron systems. A study of the brain activity of 10 year olds who observed and imitated emotional expressions and social skills found a direct relationship between the level of activity in the children's mirror neuron systems and "two distinct indicators of social functioning in typically developing children's empathy and social skills." The authors concluded that the importance of children observing and copying everyday social behaviours and the mirror neuron system "may indeed be relevant to social functioning in everyday life during typical human development" (Pfeifer et al 2008).

We know that if children do not exercise key muscles, certain weaknesses will emerge later. There may be a similar process which applies to certain brain areas. It may be that children must exercise specific brain areas and systems regularly and extensively in situ, in order to develop crucial social and emotional skills, or deficits will emerge later.

Some insight into the potential consequences of excessive DST may be seen in the study 'Deficits in early-stage face perception in excessive internet users' which found that: "Excessive internet use is associated with a limited ability to communicate effectively socially, which depends largely on the capacity for perception of the human face ... These data indicate that excessive Internet users have deficits in the early stage of face-perception processing" (He et al 2011).

Another way of looking at the issue is provided by the recent study 'Five days at outdoor education camp without screens improves preteen skills with nonverbal emotion cues.' The authors wrote: "Conclusions: ... skills in reading human emotion may be diminished when children's face-to-face interaction is displaced by technologically mediated communication" (Uhls et al 2014).

A meta-analysis of 72 studies on empathy conducted between 1979 and 2009 among almost 14,000 university students "found the biggest drop in empathy after the year 2000. College kids today are about 40 per cent lower in empathy than their counterparts of 20 or thirty years ago, as measured by standard tests of this personality trait." The researchers believe that the sheer increase in child and adolescent DST during this time could be one very important factor, and concluded that the rise of social media may also play a role in the decline in empathy: "The ease of having 'friends' online might make people more likely to just tune out when they don't feel like responding to others' problems, a behaviour that could carry over offline." They also believe electronic media has contributed to a social environment that works against slowing down and listening to someone who requires sympathy (Konrath et al 2011).

Returning to the potential role of DST in psychosocial learning, it is known that younger children experience considerable difficulty when translating to real life what they see on a screen. Children learn tasks better from a live demonstration than from an equivalent televised demonstration, a problem referred to as the "video deficit" (Zack et al 2009; 2013). This effect becomes more pronounced and may persist at older ages as the task complexity increases - and psychosocial tasks, such as perceiving and interpreting other's actions, emotions and intentions, are highly complex.

Regarding the daily time available for children to learn psychosocial skills through face-to-face interactions, studies at Stanford University have led to a 'displacement' theory of Internet use: "In short, no matter how time online is measured and no matter

Children learn tasks better from a live demonstration than from an equivalent televised demonstration.

The rise of social media may also play a role in the decline in empathy.

Electronic media has contributed to a social environment that works against slowing down and listening to someone who requires sympathy.



which type of social activity is considered, time spent on the Internet reduces time spent in face-to-face relationships... an hour on the Internet reduces face-to-face time with family by close to 24 minutes" (Nie et al 2005).

Even economists are measuring DST and the decline in direct human contact referred to as the 'Economics of Digitization'. In the study 'What Are We Not Doing When We're Online', a research economist at the Technology Policy Institute reported that: "New activities, like social media, have an opportunity cost in terms of activities crowded out.... each minute of online leisure time is correlated with 0.29 fewer minutes on all other types of leisure" including "from (offline) socialising, 0.04 minutes from relaxing and thinking, and the balance from time spent at parties, attending cultural events ... working, 0.12 fewer minutes sleeping, 0.10 fewer minutes in travel time, 0.07 fewer minutes in household activities, and 0.06 fewer minutes in educational activities" (Wallsten 2014).

Sigman (2009) reported that between 1987 and 2007 the number of hours per day of face-to-face social interaction declined markedly as the use of electronic media has increased. (See Figure 1 below):

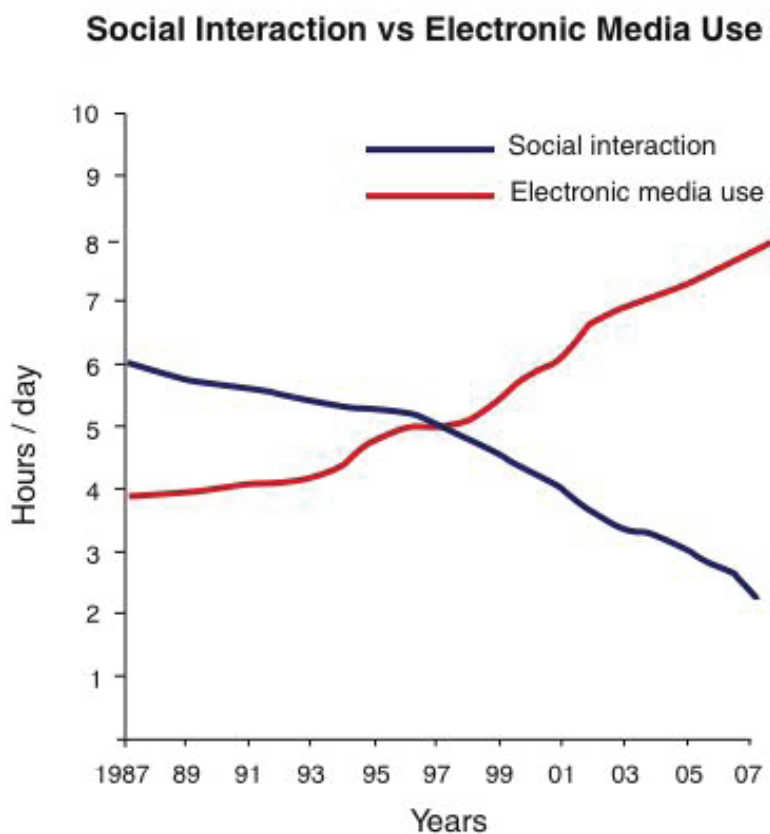


Figure 1: Hours per day of face-to-face social interaction declines as use of electronic media increases (Sigman, 2009, *Biologist*, Society of Biology).

The 3-parent family

The simple arithmetic of hours of eye-to-screen contact versus eye-to-eye contact are making clear the profound implications of such extensive DST for family and social relationships. In 2007, when children had access to far fewer screens, a large-scale study by Britain's Children's Society found that television alone was already displacing the parental role, eclipsing "by a factor of five or ten the time parents spend actively engaging with children" (Children's Society 2007).

An ongoing study of families in situ by the University of California, Los Angeles has found that social disengagement is rapidly increasing, as side-by-side and eye-to-eye human interactions in the home are being displaced by the eye-to-screen relationship.

Television alone was already displacing the parental role.

The number of parents who were ignored or unacknowledged on their return home because children were "otherwise engaged in [screen] activity... comprised a substantial percentage of observed behaviour".

It was reported that: *"family members seldom came together as a group."* The number of parents who were ignored or unacknowledged on their return home because children were *"otherwise engaged in [screen] activity... comprised a substantial percentage of observed behaviour."* The high level of being unacknowledged *"encountered by fathers when they reunited with their children was particularly striking... These latter results are particularly noteworthy. Social scientists have long documented the near universality of positive behavior in the form of greetings when two or more people reunite after being apart for a period of time. Greetings recognise a person's arrival, status and display positive intentions that universally facilitate the transition into social interaction with another."* DST continues to change this (Campos et al 2009).

However, it isn't all a one-way phenomenon. Children too are not happy that their parents' eye contact with them has markedly declined. For example, more than a third of children sampled in Sweden's cities complain that their parents spend too much time looking at phones and tablet computers, leading paediatricians to warn that children may be suffering developmental damage through benign neglect (YouGov 2013).

Although this report is concerned with screen *time*, when one includes screen *content* - which may be very much at odds with the values and desires of parents, but which children may be absorbing for many hours a day - the distorting effect on the parental role in imparting their own values and providing boundaries for adolescence could be considerable. A decade ago, in their *'Analysis of Children's Programming Provision'*, the British Government's Broadcasting Standards Commission concluded: *"The television is almost like a member of the family in its own right."* With the subsequent birth of multiple screens today, extensive DST appears to have created the three-parent family.

Both within and outside the family, children learn the rules of relationships through extensive routine face-to-face experience. Yet, as social media consumes a larger portion of a child's daily life, this is likely to create difficulties in extrapolating on-line 'un-boundaried' relationships to those of the 'real' world, thereby affecting those relationships.

The effects on family interaction and relationships may reverberate long after the children are asleep. The British National Survey of Sexual Attitudes and Lifestyles carried out once a decade published in the medical journal *The Lancet* indicates that the distractions of social media may be a reason that couples in Britain are having less sex than at any other time in the past two decades (Natsal 2013). The researchers commented: *"Modern technologies are behind the trend too. People have tablets and smartphones and they are taking them into the bedroom, using Twitter and Facebook, answering emails"* (BBC 2013).

And a growing amount of research suggests that Facebook and other social media may be playing a significant role in marital dissatisfaction and divorce. A recent study in the journal *Computers in Human Behavior* concluded: *"Results show that using social network sites is negatively correlated with marriage quality and happiness, and positively correlated with experiencing a troubled relationship and thinking about divorce.... Facebook penetration is associated with increasing divorce rates"* (Valenzuela et al 2014).

It may be that those already estranged from their spouses turn to social media. However, others suggest that in previous times extramarital affairs might have taken months or years to develop, but with Facebook, Snapchat, and dating sites, at the click of a mouse people can rediscover old flames online or strike up new relationships that lead them to stray from their marriage vows.

Passive media exposure

The family environment has been described as an ecosystem of interruption technologies. Background media that is not being actively viewed by the child is increasingly associated with developmental risks. The study of 5 - 6 year olds described earlier found that background 'passive' TV exposure was related to shorter sleep duration, sleeping disorders and overall sleep disturbances, therefore: *"Parents*

Facebook and other social media may be playing a significant role in marital dissatisfaction and divorce.

Children too are not happy that their parents' eye contact with them has markedly declined.



Both the quantity and the quality of interactions between parents and children decline markedly when background TV is on.

should control the quantity of TV viewing and ... limit children's exposure to passive TV" (Paavonen et al 2006).

A study of 1–3 year olds found that background TV significantly reduced the amount of time they played with their toys, and the amount of time they spent in focused attention during play. Researchers concluded: *"These findings have implications for subsequent cognitive development"* (Schmidt et al 2008).

Researchers have also found both the quantity and the quality of interactions between parents and children decline markedly when background TV is on, which *"may have a negative impact on development"* (Kirkorian et al 2009).

Current US estimates for children 8 months to 8 years of age are 3.9 hours of background TV per day (Lapierre et al 2012).

A new study by doctors at the New York University School of Medicine looked not only at the amount but the quality of background media children are exposed to and concluded that: *"Young children under the age of two frequently watch background media that has age-inappropriate content or has not been turned on for them to watch"* (Tomopoulos 2014).

A similar phenomenon may be occurring in New Zealand. The University of Auckland study *Growing Up in New Zealand* found 81% of the 2 year olds had spent time in a room where the TV was switched on, whether or not they were watching it. This typically occurred for 1-3 hours (for 60% of the children), or more than 3 hours (for 30%) i.e. by the time they reach age two, the majority of those toddlers watch or see background TV for between one and more than three hours per day (Morton et al 2014).

The report by the American Academy of Pediatrics entitled *'Media use by children younger than 2 years'*, *"recommends that parents and caregivers ... recognise that their own [background] media use can have a negative effect on children."* The AAP considers claims by media industry executives that educational media programmes are meant to be watched by both the parent and the child to facilitate social interactions and the learning process as having quite the opposite effect (AAP 2011).

Screen Dependency

As concern grows over the sheer *amount* of DST children are consuming, the term 'addiction' is increasingly used by health professionals to describe the growing number of children engaging in a variety of screen activities in a dependent, problematic manner. The diagnostic vernacular is still evolving: Internet Addiction Disorder (IAD), At-Risk/Problematic Internet Use, Pathological video game use, video game addiction, pathological technology use, online game addiction, and more. Although the current medical focus is on video gaming, other forms of screen use, from excessive messaging and social networking to 'porn addiction', can also become highly problematic. While there is a lack of consensus as to whether such screen use constitutes a formal psychiatric disorder, Britain's National Health Service doesn't consider it a passing phase, stating: *"As computer use has increased, so too has computer addiction."*

Prevalence

As in the United States, China, South Korea and Europe, *The Royal Australian and New Zealand College of Psychiatrists Journal* is publishing their members' research and concerns over the apparent 'addictive' behaviours linked with different screen activities – especially video gaming (King & Delfabbro 2013c). 'Addictive' behaviour in child, adolescent and young adult screen media use appears to be far more prevalent than previously thought (Sigman 2014).

Young children under the age of two frequently watch background media that has age-inappropriate content.

By the time they reach age two, the majority of those toddlers watch or see background TV for between one and more than three hours per day.

'Addictive' behaviour in child, adolescent and young adult screen media use appears to be far more prevalent than previously thought.

Prevalence rates of 'addiction' vary according to the screen activity, diagnostic tool used and age of the children. For example, a longitudinal study in *Pediatrics* of a large sample of 8–14yr olds concluded: *"Between 7.6% and 9.9% of our sample would be classified as pathological gamers at any point in time"* (Gentile et al 2011).

Non-pathologically, a study of British students' personal internet use reported that: *"Over 50% of the sample produced scores on the IAT [Internet Addiction Test] that could be considered to represent some degree of problematic behaviour."* The researchers were surprised to find *"the gender split of those with problematic internet use versus those without was even, suggesting that typical views of Internet addiction as a male problem are (certainly, now) unfounded"* (Romano et al 2013).

In evaluating problematic overuse of computer games ('addiction') in different countries, a degree of cross-cultural consistency is beginning to emerge. A national weighted sample of 1178 US youths found that 8.5% of gamers were classified as pathological gamers (Gentile 2009). Other samples in other countries yielded similar proportions, including 10.3% in China (Peng & Li 2009), 8.0% in Australia (Porter et al 2010), 11.9% in Germany (Grusser et al 2007), and 7.5% in Taiwan (Ko et al 2007).

Turkish researchers recently reported in the *European Journal of Public Health* that: *"In this study, 15.1% of students were defined as Internet addicts. Whereas the addiction rate was 9.3% in girls, it was 20.4% in boys"* (Sazmaz et al 2014).

The longitudinal study in *Pediatrics* referred to above concluded: *"The data here demonstrate, however, that most pathological gamers (84%) are still pathological gamers 2 years later....Therefore, pathological gaming is not simply a 'phase' that most children go through"* (Gentile et al 2011).

Looking to future trends in "pathological technology use (PTU)" in the form of "pathological video gaming (PVG)" and "pathological Internet use (PIU)", new research at the University of Adelaide concludes: *"These results suggest an emerging trend towards the greater uptake and use of the Internet among female adolescents, with associated PIU. Although there exists an overlap of PTU disorders, adolescents with PIU appear to be at greater risk of axis I comorbidity ['Depression, panic disorder, and separation anxiety'] than adolescents with PVG alone"* (King et al 2013).

It seems that if discretionary, seemingly dependent, screen overuse is a health and development problem, it is a problem that is unlikely to subside and more likely to increase among children and adolescents.

Irrespective of the formal status of screen 'addictions', health professionals must step back and simply consider the extent to which excessive, seemingly dependent, non-work related screen time (DST) affects the health and well-being of patients, and its impact on their ability to function including work, study, relationships and finances.

Comorbidity

There is significant co-occurrence ('comorbidity') between, for example, Pathological Internet Use and depression or ADHD symptoms. Children presented to doctors for dependent screen use as a primary problem should be screened for associated comorbidities. However, while one may assume that 'addictive' DST is a reflection of a pre-existing psychological condition, recent research suggests the relationship may be bidirectional: *"Pathological gaming seems not to be simply secondary to other disorders but to predict poorer functioning longitudinally Youths who became pathological gamers ended up with increased levels of depression, anxiety, and social phobia"* (Gentile et al 2011).

Neurological concerns

A new generation of studies is finding associations between IAD / gaming addiction and abnormal brain tissue and brain function. Although these neurological

Pathological gaming is not simply a 'phase' that most children go through.



Child health policy must adhere to the principle of precaution.

characteristics may be a precondition rather than a consequence of addiction, child health policy must adhere to the principle of precaution. Until the matter is resolved we should heed the concerns of some of the researchers as a prudent approach to protecting child well-being.

There is new evidence that playing video games induces significant structural changes in several gray matter regions in the brain. Players whose craving for games was stronger had greater structural changes. The study, published in *Molecular Psychiatry* was entitled 'Playing Super Mario induces structural brain plasticity: gray matter changes resulting from training with a commercial video game.' It reported: "Comparing a control with a video gaming training group that was trained for 2 months for at least 30 min per day with a platformer game, we found significant gray matter (GM) increase in the training group. Gray matter increases ... correlated with participants' desire for video gaming, evidence suggesting a predictive role of desire in volume [size] change." While some of the changes in gray matter may reflect improvements in areas involved in screen-based "spatial navigation" and related "motor performance", it also indicates that regular exposure to video gaming in principle may bring about changes in brain structure which reinforce desire for more gaming. Changes may be both for better and possibly for worse (Kühn et al 2014).

Differences have been found between frequent and moderate video game players in the size of reward-related brain regions implicated in cocaine, methamphetamine and alcohol addiction suggesting possible "adaptive neuroplasticity [brain structure changes] in frequent adolescent video game players" (Kuhn et al 2011).

Other studies report "abnormal white matter integrity in adolescents with internet addiction disorder" in a wide variety of "major white matter pathways... throughout the brain." The authors speculate that "heavy internet overuse, similar to substance abuse, may damage white matter microstructure." Interestingly, these are some of the same brain areas found to exhibit abnormal white matter integrity in substance addictions such as heroin, cocaine and alcohol (Lin et al 2012, see Figure 2).

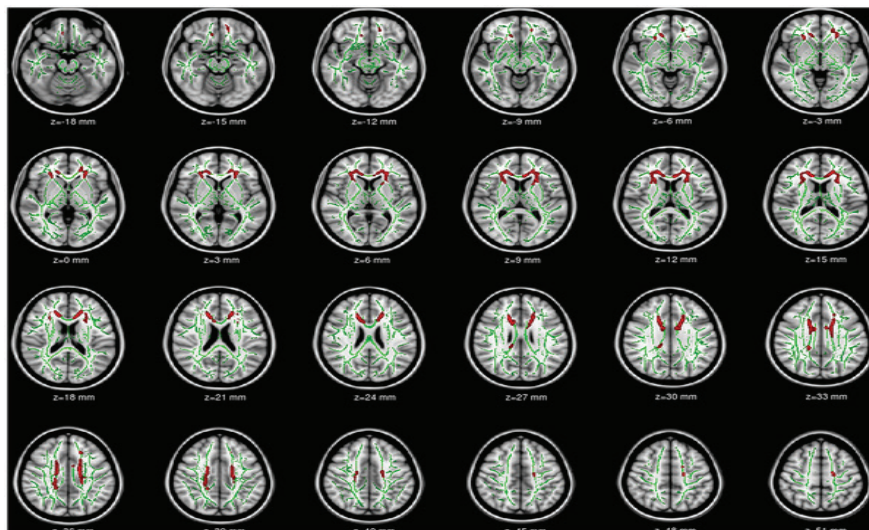
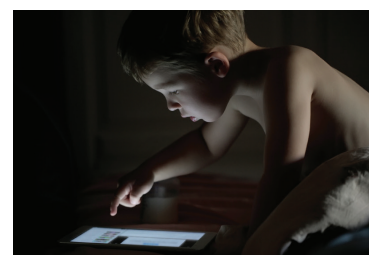


Figure 2: Red areas indicate abnormal white matter in the brains of adolescents with Internet addiction disorder (Lin et al 2012).

Adolescents with "online game addiction" are found to exhibit "microstructure abnormalities of gray and white [brain] matter" (Weng et al 2013).

The study 'Cortical Thickness Abnormalities in Late Adolescence with Online Gaming Addiction' observed a link "between cortical thickness and duration of online gaming addiction in late adolescence." The more months the adolescent exhibited gaming addictive behaviours, the more abnormal the thickness of their brain's cortex in several different areas. There also appear to be differences in brain function as the study also reported "...adolescents with online gaming addiction showed impaired cognitive control ability" (Yuan et al 2013, see Figure 3).



Adolescents with online gaming addiction showed impaired cognitive control ability.

Their brains exhibit an increased sensitivity to the rewards (winning) and an insensitivity to losing.

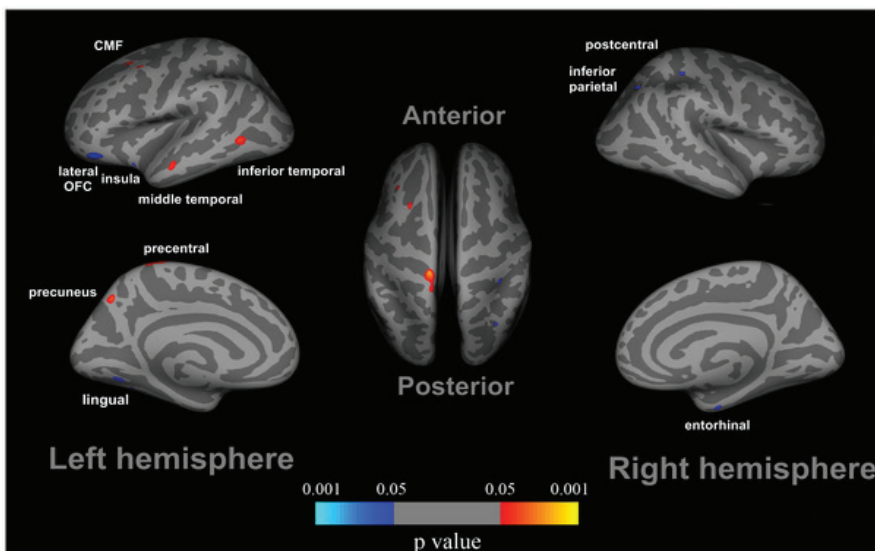


Figure 3: Coloured areas indicate cortical thickness differences in adolescents with online gaming addiction compared with healthy controls (Yuan et al 2013).

Other studies have found that among “online game addicts”, researchers successfully induced increased activity in “crave related brain areas” merely by showing them pictures from a computer game (Sun et al 2014).

The general connection between key brain areas that should be functioning in tandem may also be reduced. “Decreased functional brain connectivity” described as “widespread and significant” is reported as more prevalent in adolescents “with internet addiction” (Hong et al 2013). For example, on tests of impulse control, such adolescents “fail to recruit the frontal-basal ganglia pathway believed to inhibit unwanted actions” (Li et al 2014).

A study published in *Biological Psychiatry* asked ‘What makes Internet addicts continue playing online even when faced by severe negative consequences?’ The researchers observed that brain activity in people with IAD indicates that while they are playing a video game their brains exhibit an increased sensitivity to the rewards (winning) and an insensitivity to losing (Dong et al 2013).

Dopamine is a key chemical component of the brain’s reward system (e.g., ventral striatum and caudate), and is heavily implicated in the formation and maintenance of addictions. Significant dopamine release within the brain’s reward system is found to occur quickly in young adult brains while playing computer games (Koepp et al 1998; Weinstein 2010).

A study in the *American Journal of Drug Alcohol Abuse* reported a 10.5% change in dopamine release “in the caudate after playing a motorbike riding computer game.” The researcher highlighted “growing concerns that extensive computer game playing may lead to long-term changes in the [brain’s] reward circuitry that resemble the effects of substance dependence” (Weinstein 2010).

Further studies find that reduced numbers of specialised brain cells - dopamine receptors and transporters (Kim et al 2011) - have been found in the brains of ‘internet addicts’ leading some researchers to speculate that this may reflect “neuropathologic damage to the dopaminergic neural system caused by Internet Addiction Disorder” (Hou et al 2012).

The addictive potential of a substance or activity is influenced by the speed with which it promotes dopamine release and the intensity and reliability of that release, and many video games are designed to offer an extremely effective ‘reward schedule’ which is likely to facilitate dopamine release.

Early extensive screen exposure appears to be more likely to lead to a long-term lifestyle of higher screen exposure.



Beyond excessive computer game use, young discretionary screen viewing begets more viewing. Early extensive screen exposure appears to be more likely to lead to a long-term lifestyle of higher screen exposure which in turn may increase the risk of screen dependency:

High dose ST from early age → ↑ risk of screen dependency

Child risk factors

Susceptibility to addictions can start much earlier than we thought. For example, the brain can be programmed in the womb for later addiction by exposing a fetus to alcohol or drugs (Youngentob & Glendinning 2009; Middleton 2009).

Children are more susceptible to developing a long-term problematic dependency on technology. The age of initiation and level of exposure to, for example, gaming may increase this risk, which may start much earlier than assumed. Kirzinger et al (2012) reported: "a substantial portion" of individual differences "in media habits can be attributed to genes." Prenatal exposure to higher levels of androgens (male hormones) in the womb is associated with later "problematic video gaming behavior" and "video game addiction" (Kornhuber et al 2013).

Parental role modelling is another important factor: parents who consume high DST have children who are many times more likely to consume high DST. With a dramatic rise in the number and range of screen devices children have access to and commensurate rise in DST, coupled with a marked drop in the age of high consumption, problematic screen use is a growing problem.

There is a lack of consensus over diagnostic criteria and treatment for 'addictions' to various screen activities. Doctors are advised to focus on the person's ability to function, without being preoccupied with formal diagnostic categories (Sigman 2014). However, for now, it is prevention that should be the focus of intervention.

Parental role modelling

Role modelling is a key influence on child DST. Parent and child levels of screen viewing are strongly related: children who live in a household that promotes TV-watching (TV is on when the child comes home from school, and meals are eaten in front of the TV) are more likely to watch excessive amounts of television themselves. If parents watch television for more than four hours/day, their son and daughter, respectively, will be 10.5 and three times more likely to watch it for more than four hours/day too (Jago et al 2010).

This phenomenon appears early in life and includes other screen devices and activities too. In the study of 'Associations between the screen-time of parents and young children', researchers concluded that: "Results show that time spent SV [Screen Viewing] of both fathers and mothers is strongly associated with child time spent SV, highlighting the need for interventions targeting both parents and children" (Jago et al 2014).

Babies and toddlers

The Australian Government's Department of Health has issued formal screen time guidelines: "Children younger than two years of age should not spend any time watching television or using other electronic media (DVDs, computer and other electronic games)" (ADOH 2011).

The US Department of Health does the same as does the American Academy of Pediatrics (USDH 2014; AAP 2011; 2014b), which adds: "Media - both foreground and background - have potentially negative effects and no known positive effects for children younger than 2 years." The Canadian Paediatric Society has gone further: "No

Children younger than two years of age should not spend any time watching television or using other electronic media.

Australian Government's Department of Health

Susceptibility to addictions can start much earlier than we thought.



No child should be allowed to have a television, computer or video game equipment in his or her bedroom.

Canadian Paediatric Society

child should be allowed to have a television, computer or video game equipment in his or her bedroom” (CPS 2003).

The French Government prohibits French channels from airing all TV programmes - educational and otherwise - aimed at children under three years of age (High Audiovisual Council 2008).

80 per cent of adult brain size growth occurs during a child’s first three years when they may be most vulnerable to the potential effects of screen media. Furthermore it is imperative that significant periods of time, when infants and toddlers could be learning about the people and things around them and the sensations within them, are not displaced by screen time. It appears that children must first ‘upload’ information about the 3-D non-virtual environment, before they begin to experience virtual versions of it.

The American Academy of Pediatrics felt compelled to issue a “News Release: ‘BABIES AND TODDLERS SHOULD LEARN FROM PLAY, NOT SCREENS’”, highlighting the following:

- Many video programs for infants and toddlers are marketed as ‘educational’ yet evidence does not support this.
- Unstructured play time is more valuable for the developing brain than electronic media.
- Young children learn best from - and need - interaction with humans, not screens.
- Instead of screens, opt for supervised independent play for infants and young children during times that a parent cannot sit down and actively engage in play with the child.
- Avoid placing a television set in the child’s bedroom; and
- Recognize that their own media use can have a negative effect on children (AAP 2011b).

The AAP also issued a ‘Policy Statement’ addressing:

1. “the lack of evidence supporting educational or developmental benefits for media use by children younger than 2 years,
1. the potential adverse health and developmental effects of media use by children younger than 2 years, and
1. adverse effects of parental media use (background media) on children younger than 2 years.”

The AAP considers claims by media industry executives “that educational media programmes are meant to be watched by both the parent and the child to facilitate social interactions and the learning process” as having quite the opposite effect (2011).

An unprecedented recent policy statement by the AAP along with a technical report addressing ‘School Readiness’ and ‘Translating Developmental Science Into Lifelong Health’, is now recommending aggressive intervention by paediatricians to strongly encourage parents to read to/with and speak to/with their infants and preschool children: “Reading regularly with young children stimulates optimal patterns of brain development and strengthens parent-child relationships at a critical time in child development, which, in turn, builds language, literacy, and social-emotional skills that last a lifetime.”

Interestingly, the AAP takes the exact opposite view of screen time for young children: “Children younger than 2 years [should] not view electronic media.” Reading is “offering parents a positive alternative for entertaining young children, for nurturing early relationships” highlighting for parents “the importance of their ‘face time’, interactive conversations, and their own evolving and essential relationship with their children, which



Children must first ‘upload’ information about the 3-D non-virtual environment, before they begin to experience virtual versions of it.

Young children learn best from – and need – interaction with humans, not screens.

Avoid placing a television set in the child’s bedroom.

Reading regularly with young children stimulates optimal patterns of brain development and strengthens parent-child relationships at a critical time in child development.

is critical to setting a young child's developmental trajectory and life course ... In contrast to often either passive or solitary electronic media exposure, parents reading with young children is a very personal and nurturing experience that promotes parent-child interaction, social-emotional development, and language and literacy skills during this critical period of early brain and child development" (AAP 2014).

The 'video deficit' effect

Children learn tasks better from a live demonstration than from an equivalent televised demonstration, a problem referred to as the *video deficit* (Zack et al 2009; 2013).

For example, a recent study published in *Child Development* found that 'educational' TV shows/video training do not help toddlers learn words and that young children need to have two-way conversations to develop language: "*Children only learned novel verbs in socially contingent interactions*" (Roseberry et al 2014).

The apps industry continues to differentiate itself from 'educational' TV and videos and entice parents and 'early learning' institutions with the idea that screen apps are an entirely different thing "*because they allow the child to interact with their digital environment.*"

Educational implications

At the other end of the age spectrum - 'emerging adulthood' - the amount of DST an 18 year old consumes during their spare private time may have a negative effect on their college grades according to a team at Brown University Medical School publishing '*Female College Students' Media Use and Academic Outcomes: Results from a Longitudinal Cohort Study.*'

College students' media use may differ from adolescents in important ways: "*Whereas adolescents are required to attend a structured day of high school and are usually subject to at least some parental monitoring, college students generally have fewer restrictions on their time and behavior, potentially allowing for dramatic shifts in media use. First-year college students, in particular, must learn to balance many options for their free time and academic responsibilities.*"

After first reviewing existing research on levels of DST and "*emerging adults in college*", the team concluded: "*Overall, most forms of media use are negatively associated with academic outcomes.*" They then assessed 11 forms of media use and later academic outcomes, reporting: "*In general, media use was negatively associated with academic outcomes after controlling for prior academics and demographics ... Results show that female college students are heavy users of new media, and that some forms of media use may adversely impact academic performance ... Academic counselors may consider assessing college students' media use and encouraging them to take breaks from media*" (Walsh et al 2013).

There are now questions concerning the headlong rush toward 'e-learning' in the classroom itself. Despite the contemporary belief that screen use in classroom education is equal or superior to traditional forms of learning, the study '*The Pen Is Mightier than the Keyboard: Advantages of Longhand over Laptop Note Taking*' came to an entirely different conclusion. Researchers at Princeton University reported in the journal *Psychological Science*: "*In three studies, we found that students who took notes on laptops performed worse on conceptual questions than students who took notes longhand...detrimental to learning...impairing learning because their use results in shallower processing*" (Mueller & Oppenheimer 2014).

The Ministry of Health recently stated: "*The Ministry has not provided any guidelines regarding the amount of screen time during school hours to the Ministry of Education*" (NZMOH 2014), while the Ministry of Education offers unspecific advice to parents: "*It's a good idea to make sure your child's 'screen-time' is balanced with other activities to ensure their health, safety and happiness*" (NZMOE 2014).

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Ministry of Education

Recommendations

Some argue that society has 'moved on' and that high DST is a reality of the modern world. Children's medical needs however, have not 'moved on'. There are some biological and developmental realities and limits to the sheer amount of DST that children can tolerate physiologically and developmentally.

Interventions

There is good evidence that children's DST can be reduced partly through raising parental awareness and by parents incorporating screen rules into family life. A systematic review by researchers at Harvard Medical School reported that 29 studies "achieved significant reductions in TV viewing or screen-media use" (Schmidt et al 2012). Research by the Centers for Disease Control and Prevention (CDC), along with other studies, has found parental rules and limits on DST effectively reduce DST, as does not having screens in bedrooms (Carlson et al 2010; Ramirez et al 2011). The CDC study also found a negative dose-response relationship between weekly physical activity and the risk of exceeding recommended DST limits, recommending the promotion of physical activity as an additional means of reducing DST.

More physical activity this week, for example, is increasingly linked to a later reduction in child DST for reasons that are not fully understood. Therefore, involving children in more physical activity is suggested.

A recent study on 'Parenting style, the home environment, and screen time' found "that in families with rules about screen time, children were less likely to watch TV >2 hours/day" and "The number of TVs and computers or game consoles in the household was positively associated with [more] screen time" (Veldhuis et al 2014).

Other research, appearing in the *Journal of Adolescent Health*, entitled 'Adolescent Screen Time and Rules to Limit Screen Time in the Home' concluded that "having clear rules, setting limits on screen time, and not having screen-based media in the bedroom were associated with fewer hours of screen time for adolescents" (Ramirez et al 2011).

Parental rules on DST have longer-term implications for child health. The *Journal of the American Medical Association: Pediatrics* recently published the study 'Parental Monitoring of Children's Media Consumption: The Long-term Influences on Body Mass Index in Children.' Mothers who monitored their child's DST early on had children with a healthier body mass index years later: "RESULTS:...significant negative effect of maternal media monitoring on children's BMI." The researchers added: "These effects held when more general parental monitoring, and parent BMI, annual income, and educational level were controlled for ... parental behaviors related to children's media consumption may have long-term effects on children's BMI" (Tiberio et al 2014).

It seems mothers must now be encouraged to nag.

Parents are led to believe both by their children and those offering screen entertainment that now that a new generation is used to regular screen entertainment they will not be able to cope without it. Children, it is feared, will sit immobile and pout without their devices. However a study in the *BMJ Open*, entitled 'To remove or to replace traditional electronic games? A crossover randomised controlled trial on the impact of removing or replacing home access to electronic games on physical activity and sedentary behaviour in children aged 10 - 12 years', found parents' worst fears may be unfounded: "Results: ... removal of all electronic games resulted in a significant increase in moderate to vigorous physical activity and a decrease in sedentary time" (Straker 2013).

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Health professionals

Family physicians in the US are now encouraged to take a 'media history' from patients and discuss connections between a child's health and behaviour and their screen use. They can also provide anticipatory guidance to families about media in the home, including limiting media use, raising the age and reducing the degree of exposure, and discouraging screens in children's bedrooms. Health professionals in New Zealand should consider incorporating this element into their dealings with families.

Interventions targeting families can also take the form of more prominent formal statements by medical and health bodies on problematic screen use and an information leaflet / poster on the subject helping to create a cultural shift and a reference point for healthy behaviour.

The associations between DST and health occur generally beyond two hours per day. Yet the average child is exposed to 2 - 4 times this amount. Therefore, reducing total daily DST for children could provide significant advantages for children's health and well-being.

A negligent vagueness has pervaded the official vernacular surrounding child DST. For example, the Ministry of Education suggests to parents that they should consider "providing balance" (NZMOE 2014). Although popular phrases such as 'striking a balance' or 'everything in moderation' may sound reassuringly sensible, one of the main obstacles to reducing our children's DST is the vagueness of the terms 'moderation' and 'excessive'. Such terms are now being defined by considering DST as simply another form of consumption measured in units of hours/minutes consumed per day - a simple public health concept to grasp and act upon. Considering the existing empirical research and position of medical bodies and governments, the following guidance on DST (e.g., before and after school) are only *ideals* for parents. Even if they are not adhered to, it is important to establish such ideals as a reference point to work from.

Parents

80 per cent of adult brain size growth occurs during a child's first three years, when they may be most vulnerable to the effects of screen media. There should be a buffer zone in the early years, whereby this stage of child development is 'cordoned off' from premature exposure to screen media. Screen viewing should be delayed, or minimised, until age three years.

Where possible, encourage no screens in children's bedrooms.

Parents of younger children should be advised to choose screen material with a slower pace, less novelty and more of a single narrative quality.

Parents should be encouraged to monitor and control the time their children spend on hand-held computer games / media / tablets / smartphones with justification that DST is now officially a health and development issue not merely a lifestyle / cultural one.

Most importantly, children from an early age must be helped to develop an awareness of their discretionary screen time as a health and development issue. Moreover, they must cultivate the self-discipline and screen habits that will enable them to keep their consumption at an acceptable level throughout their lives.

Ideal discretionary DST limits are:

3 - 5 years:.....0.5 – 1 hour/day
5 - 7 years:.....1 – 1.5 hour/day
7 - 12 years:.....1 – 1.5 hour/day
12 - 15 years:.....1.5 – 2 hour/day
16+.....2 hour/day

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Parents must take into consideration how much time their children are spending doing homework on computers before coming to a decision on DST for their child.

Parents should be aware of the role modelling influence their own viewing habits may have on their children along with the potential influence of background or 'passive' media.

If challenged by their children, parents can justify their own adult screen time because of the simple fact that parents' brains and bodies are not still developing – they are fully formed and screen time does not have the same effects on them.

Societal

- Schools can feel justified in adopting a guidance position on the amount of DST children spend out of school and communicate this to pupils and parents. Home life affects academic achievement. Schools and/or the Ministry for Education may also consider adopting a position on the amount of time children spend in front of a screen *in* school.
- The Ministry of Health should consider DST as a personal health and well-being issue to be formally included in the health education curriculum and taught in the classroom from primary school.
- Where possible, IT Departments within schools can advise parents on reducing Internet access and closing down functions on various devices.
- Information about infants and toddlers watching screens should be included within maternity ward 'birth packs' given to mothers.
- Health visitors should be aware of medical evidence and advise new parents.
- Nurseries and day care centres should make parents aware of this issue, as is the case in Belgium and France.
- The Ministry of Health should address the lack of guidelines for age groups birth to 2 years and from age 2 – 5 years.
- The Ministries of Health and Education should issue clear statements regarding the need for DST limits. Such communications should raise public awareness of the full *range* of concerns attending high DST.

Advice for children

Ultimately it is most important to help children cultivate a degree of self-discipline in their discretionary use of screen media. Messages can include:

- Set time limits – don't waste time watching hours of content. How frequently do you really need to check your profile? Aim for a maximum of 2hrs per day of screen entertainment.
- Take breaks every half hour - even for homework.
- Protect study time:
 - do one thing at a time
 - switch devices / social media alerts off
 - if necessary use 'anti-distraction' apps
- Have a no-screen gap before sleep.
- Turn off and sleep:
 - don't take your screen to bed
 - use alarm clock, not a screen device / Smartphone
- Unplug – dedicate certain times in week / day to being unplugged, encourage family to join you.
- Find new boredom busters – interests / passions to enjoy and dedicate time to offline.

Parents should be aware of the role modelling influence their own viewing habits may have on their children.

The Ministry for Education may also consider adopting a position on the amount of time children spend in front of a screen in school.



Set time limits.

Take breaks.

Have a no-screen gap before sleep.

Advice for parents

To recap, here are key points to be communicated to parents:

- Reduce child's discretionary screen exposure.
- Establish rules / limits.
- Consider screen access / availability e.g. bedroom.
- Remember blue light (consider glasses/filters).
- Minimise background media: passive viewing.
- Monitor child's screen use.
- Be aware of parental screen role modelling.
- Have 'screen-free' dinners:
 - turn all devices off and place in a 'tech basket'
- If necessary, turn off wifi at night.
- If necessary, stop paying Smartphone rent for your child.
- Focus on *alternatives* to DST:
 - physical activity
 - social activity
 - hobbies
 - 'dopamine-producing' pastimes

However, while health professionals can raise parental awareness, ultimately parents must stop being their child's enabler and start to parent authoritatively. In the face of a screen-consumed generation, they must learn to say "no" with conviction.

Political implications

Perhaps because ST is not a dangerous substance or a visibly risky activity, it has eluded the scrutiny that other health issues attract. Additionally, there is little funding and public gratitude in looking for the negative effects of the world's favourite pastime.

In 2006, American paediatric researchers writing in the American Medical Association's *Archives of Pediatric and Adolescent Medicine* asked rhetorically: "Why is it that something that is widely recognised as being so influential and potentially dangerous has resulted in so little effective action? To be sure, there has been some lack of political will to take on the enormously powerful and influential entertainment industry ... [Screen] media need to be recognised as a major public health issue" (Christakis & Zimmerman 2006).

Today, researchers in New Zealand trying to reduce child screen consumption, writing in the *Journal of Epidemiology and Community Health*, state: "Unlike the case for tobacco, there is no easy way to tax media consumption. Media industries have no incentive to encourage children to reduce their use. For parents, television and other digital media offer a convenient (and apparently safe) way to entertain their children, and children resist attempts to limit their screen time. Governments see technology as the key to economic progress and want children to become media-savvy 'digital citizens'. Meanwhile, children and young people are exposed to more and more forms of electronic media with little regard to the long-term health consequences. Children, of course, should not be expected to understand the risks and take long-term responsibility for their viewing habits, but childhood appears to be the time when excessive screen time does the most harm" (McAnally & Hancox 2014).

Conflicts of interest

Rather than paediatricians and child health specialists, it has been the academics in ICT, media literacy, education, marketing and social and cognitive psychology whose research is often funded by TV, software and technology and 'e-learning' industries

Consider screen access and availability.

Have 'screen-free' dinners.

Focus on alternatives to discretionary screen time.

Parents must stop being their child's enabler and start to parent authoritatively.

There is little funding and public gratitude in looking for the negative effects of the world's favourite pastime.

Governments see technology as the key to economic progress and want children to become media-savvy 'digital citizens'.

who have dominated research, public and professional understanding of, and policy considerations on, ST and child health. Few seem to have spotted the most salient point: their focus is not on child health, but as one leading institution advising successive British governments states: “Research focuses on children’s and young people’s interactions with electronic media and on media education.”

Information hygiene

Moreover, while many medical journals have instituted measures to identify competing interests and sources of funding in order to minimise such influence within their publications, thereby maintaining a high standard of information hygiene, the culture and standard of hygiene with respect to research on screen media and children is very different in media, psychology and education journals.

As the most valid impartial arbiter of child health, paediatric and family medicine must in future be at the centre of research, public understanding and policy formation on ST.

In other areas of child health and development, when considering the potential effects of profound new developments, society instinctively adopts a principle of precaution. Yet, to date, the increasingly excessive levels of child DST have been met with equivocation.

In future, policy makers should, to the best of their ability, excise the influence of the screen-related industries. When considering any evidence on child screen use presented to them, policy makers should be highly vigilant in ensuring a high degree of ‘information hygiene’ and establish whether screen-related industries have played any part in such research.

Conclusion

While many questions remain regarding the precise nature of the association between DST and adverse outcomes, the advice from a growing number of both researchers and other medical associations and government health departments is becoming unequivocal: reduce discretionary screen time.

Better safe than sorry. Irrespective of whether this will endear doctors and politicians to the public or not, medical bodies and government ministries should formally and vociferously express concern over current levels of discretionary screen time. Moreover, they must focus not on what families and voters are *interested* in hearing, but what is in their children’s best interests.

Paediatric and family medicine must in future be at the centre of research, public understanding and policy formation on ST.

The increasingly excessive levels of child DST have been met with equivocation.

Reduce discretionary screen time.

They must focus not on what families and voters are interested in hearing, but what is in their children’s best interests.

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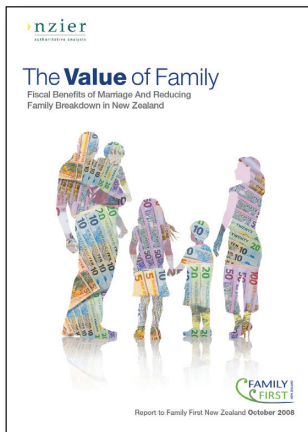
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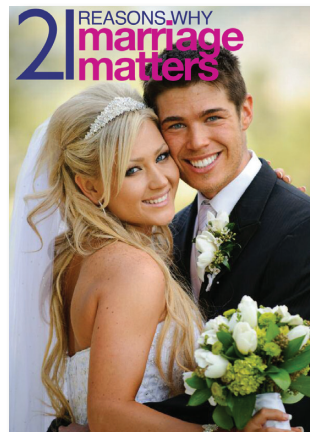
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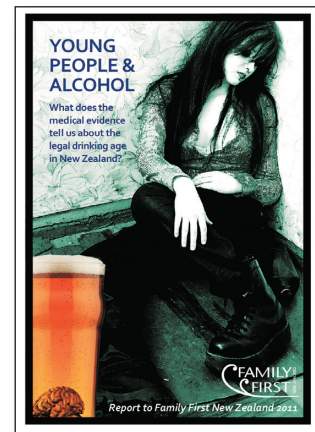
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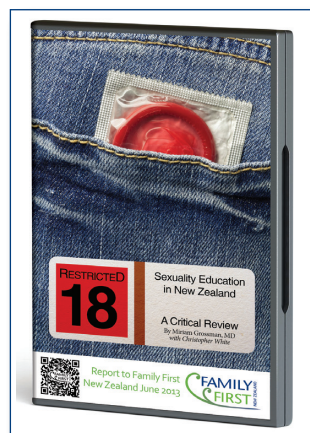
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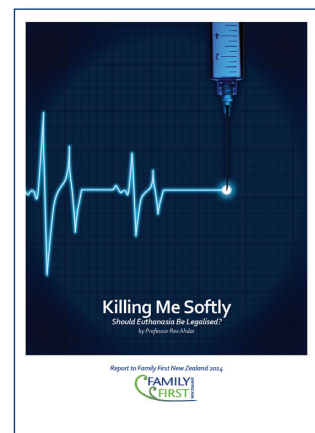
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