# The Estimated Impact of Reallocating Time Between Sedentary Behaviours on Behavioural and Mental Health Outcomes

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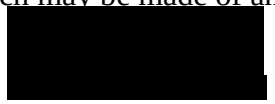
Signature [of author]: 

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## ABSTRACT

Currently, there is evidence of many health and social benefits from limiting time in sedentary behaviour (SB). However, there is still much research to be done on whether all types of SB are detrimental to all aspects of children's health. For example, whether watching TV, playing video games, talking on the phone, surfing the internet, or reading all have similar relationships with health and behavioural indicators among children and youth. The objective of this study was to estimate the impact of replacing one time-based SB with another using the isotemporal substitution method (ISM). 5621 total participants (49% boys) in grades 5-12 from PEI schools were given the SHAPES-PEI questionnaire. Students self-reported time spent watching/streaming TV shows or movies, playing video/computer games, talking on the phone, surfing the internet, and reading for fun, as well as the following health outcomes: mental fitness, academic achievement, pro-social behaviour, and bullying. ISM was used to estimate the impact of replacing one time-based SB with another. Results from the ISM indicated that replacing other forms of SB with reading for fun was consistently associated with having high mental fitness, high academic achievement, increased pro-social behaviour, and not bullying others. Replacing other SBs with time spent surfing the internet and talking on the phone were associated with detrimental effects on the above outcomes. Our results suggest that not all forms of SB have similar relationships with health indicators and replacing screen-based SB with reading may have benefits among children and youth.

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## Abbreviations

| | |
|---|---|
| SB | Sedentary Behaviour(s) |
| METs | Metabolic Equivalents |
| SBSB | Screen-Based Sedentary Behaviour |
| NSBSB | Non-Screen-Based Sedentary Behaviour |
| SHAPES-PEI | School Health Action Planning and Evaluation System-Prince Edward Island |
| ISM | Isotemporal Substitution Model |
| CSHR | Comprehensive School Health Research Group |
| CSTADS | Canadian Student Tobacco, Alcohol and Drugs Survey |
| LPA | Light Physical Activity |
| MVPA | Moderate-Vigorous Physical Activity |

# INTRODUCTION

All behaviours in a day independently and collectively affect health, cognition, and development in children and youth (Walsh et al., 2018). Although it has been determined that the 24-hour movement guidelines include at least 60 minutes of physical activity per day, 2 hours or less of screen time per day, and 9-11 hours of sleep per night, less than one-fifth of Canadian children are meeting all three of these recommendations (ParticipACTION, 2018). Within these behaviours, sedentary behaviour (SB) is among the most concerning as only about half of North American children are meeting the screen time guideline (Saunders & Vallance, 2016). This is important to note because different types of SB could contribute differential impacts on the health of children and youth (Cabanas-Sánchez et al., 2018). Specifically, screen-based sedentary behaviour (SBSB) has been linked to numerous harmful health indicators. So given the widespread severity, increased health concerns, and novelty of the topic of SB, with most studies to date primarily focusing on SBSB and adiposity (Hunter, Leatherdale, & Carson, 2018), it is essential to address that not all SBs are the same. It is crucial to investigate how all forms of SB affect the lesser studied mental and behavioural health outcomes of school-aged children and youth when they are swapped for one another.

# LITERATURE REVIEW

## Sedentary Behaviour

As of recently, sedentary behaviour (SB) has become a heavily researched topic in the health world. It refers to any waking behavior characterized by an energy expenditure of ≤1.5 metabolic equivalents (METs), while in a sitting, reclining, or lying posture (Tremblay et al., 2017). Such behaviours have since been identified as causing many health issues that the population is facing today, especially for impressionable children and youth. For instance, the effects of frequent smartphone usage could be more damaging to children than adults due to their higher neural plasticity, but this currently remains untested (Wilmer, Sherman, & Chein, 2017). Traditionally, SB has been measured as one thing, or just time spent being sedentary in front of screens. Recently, researchers have been trying to discriminate between different forms of sedentary behaviour and determine if they all have the same effect on health indicators. For example, Cabanas-Sánchez et al. (2018) measured SB by dividing it into four categories being screen-based SB, such as watching TV, educational-based SB, such as doing homework, social-based SB, like sitting and talking to someone, and other-based, like doing cognitive hobbies or traveling on motorized transport. And interestingly, Costigan, Barnett, Plotnikoff, & Lubans (2013) noted that less energy is expended during screen-based sedentary behaviours (SBSBs) such as watching TV as compared to non-screen-sedentary behaviours (NSBSBs) like playing board games, writing, and reading. For the purpose of this study, SB will be simply divided into two categories being SBSB and NSBSB, of which includes all other forms of being sedentary without using a screen.

SBSB has been linked to adverse health effects of people of all ages. In adults, sedentary time has become significantly linked with overweight and obesity, cardiovascular disease, unfavourable metabolic status, poor fitness, osteoporosis, diabetes, breast cancer, and impaired psychosocial functioning (Costigan et al., 2013). These alarming effects display why it is imperative to address this issue at a younger age to attempt to mitigate potential disease that is arising earlier and earlier in age as we speak. Costigan et al., (2013) state their concern about this because the greatest increases of SB have been documented in early adolescence which is related to significant increases in body weight. This is then linked to bad habits that are likely to continue throughout adulthood. That is why it is crucial to study SB among children and youth. The behaviours children and adolescents engage in during a typical 24-hour period are crucial for brain development and cognitive performance (Walsh et al., 2018). Currently, it is recommended, through the Canadian 24-Hour Movement Guideline for Children and Youth, that they obtain at least 60 minutes of physical activity per day, 2 hours or less of recreational screen time per day, and 9-11 hours of sleep per night (Walsh et al., 2018). According to the ParticipACTION Report Card (2018), 51% of 5-17-year-olds in Canada are engaging in more recreational SBSB than the recommended amounts, and this number is becoming increasingly more significant every year (Saunders & Vallance, 2016). Hale and Guan (2015) stated that school-aged children spend approximately seven hours in front of a screen each day. This is concerning because higher frequencies of SBSB can be connected to unfavourable body compositions, higher indicators of cardio metabolic risk, decreased physical fitness, and reduced signs of emotional and social health, such as low self-esteem, unfavourable behavioural conduct and pro-social

behaviour, depression, stress, and aggression (ParticipACTION, 2018). Carson, Tremblay, Chaput, and Chastin (2016b) describe that SBSBs, such as television viewing, consistently show detrimental associations with health; however, the same results are not seen in total sedentary time. Other sedentary behaviours, such as reading, may not have the same adverse effects as SBSBs. As opposed to television viewing, reading has more positive implications for cognitive development in children (Lee & Carson, 2017). More time spent reading and doing homework was associated with higher academic achievement in school-aged children and youth (Carson et al., 2016a), as well as favourable social, emotional, and interactive skills (Lee & Carson, 2017). It must also be noted that SBSB is a source of unfavourable health outcomes in children and youth independent of other health-related behaviours, such as physical activity, carried out throughout the day (Saunders & Vallance, 2016; Costigan et al., 2013). Even if someone is physically active and meeting the guidelines, the time spent in SB has separate associations with poor health. There are a fixed number of hours in a day, and although SB often takes up most of that time, the more time spent with screens rather than physical activity or sleeping is associated with reduced health outcomes.

## Mental Fitness

As reported by Cusack and Thompson (1998), mental fitness encompasses thinking clearly and creatively, problem-solving, memory abilities, learning, expressing ideas, setting goals, and having a positive mental attitude with optimism, self-esteem, confidence, and mental flexibility. The School Health Action Planning and Evaluation System- Prince Edward Island (SHAPES-PEI) (2015) survey defines it as a student's overall well-being, whether it be emotional, social, or psychological. Mental fitness arises

when the three interrelated needs of competence, autonomy, and relatedness are all achieved (SHAPES-PEI, 2015). This stems from Ryan & Deci's (e.g., 2000, 2008, 2017) positive psychology approach of Self-Determination Theory (SDT) that stresses the importance of satisfying autonomy, competence, and relatedness as core psychological needs, with each being independently important (Ryan & Deci, 2017). When these needs are met, children and youth can contribute to their well-being as well as the well-being of others. The failure to satisfy any of these needs will result in reduced growth, integrity, and wellness. When there is frustration due to a hindrance of these basic needs, it is associated with greater ill-being and weakened functioning (Ryan & Deci, 2017). SDT argues that the origin of many psychological problems and psychopathologies are rooted in a combination of need deprivation or damage during development (Ryan & Deci, 2008). Therefore, when excessive control, non-optimal challenges, and lack of connectedness are present in a child's environment, it disrupts inherent tendencies and can result not only in the absence of initiative and responsibility but also in distress and psychopathology (Ryan & Deci, 2000).

Currently, the direct associations of mental fitness to all sedentary behaviours are limited in research, but its connections with screen-time have been well documented. Saunders and Vallance (2016) state that the more SBSB, the worse the outcomes, especially in mental fitness components such as psychological well-being, self-esteem, anxiety, and depression. Furthermore, a dose-response finding was explored in a study by Liu, Wu, and Yao (2015) who found that youth with high daily SBSB, most notably when greater than two hours, compared to those with no SBSB, were 12% more likely to be at risk for depression. Additionally, the opposite connection was documented in an

intervention by Lubans et al. (2016), as they found that decreasing the screen time and increasing the autonomy of adolescent boys gave rise to greater well-being. Although these findings are primarily negative toward screens, some SBSB can lead to positive outcomes in mental fitness. Using online communication, whether it be on a laptop or smartphone, can be used to strengthen existing friendships, meet new friends, spend more time face-to-face with friends, and more online chatting can predict better friendship quality and overall well-being (George & Odgers, 2015; Lenhart, Smith, Anderson, Duggan, & Perrin, 2015). The addition of strong friendships at this young, developmental age can greatly benefit the basic psychological needs. Based on this inconsistent research, there is still work to be done regarding the associations among mental fitness outcomes and different types of sedentary behaviour.

## Academic Achievement

A person's educational level and success in schooling are referred to as academic achievement. It is important to assess what effects SB is having on academic achievement in childhood and adolescence, as success as this age is a strong predictor of future wealth, productivity, and overall health (Faught et al., 2017). Previous research has shown positive relationships between physical activity and academic achievement and negative relationships between sedentary behaviour and academic achievement (Bezold et al., 2014; ParticipACTION, 2018). However, meeting multiple movement behaviour recommendations together, such as sleep and screen time, had a stronger effect on academic achievement, especially reading and writing, than meeting just one guideline behaviour (Faught et al., 2017). Recently, studies have recognized that some SB can be beneficial to success in school. According to ParticipACTION (2018) and Carson et al.

(2016a), NSBSB such as reading and homework appears to have a positive effect on academic achievement. Interestingly, Tang and Patrick (2018) found a benefit of SBSB, as they stated that using a computer was positively related to academic achievement independent of individual-and family-level characteristics, as computers are becoming essential for students to complete their school work.

However, multiple longitudinal studies have found that SBSB, specifically TV viewing, is negatively associated with academic performance (Carson et al., 2016a; Saunders & Vallance, 2016). Most of the research studying the relationship of SBSB and young adolescents' academic achievement has only focused on certain types of technology and digital media sources; therefore, there is an incomplete understanding of its effects (Tang & Patrick, 2018; Walsh et al., 2018). Because of the lack of consensus, there is growing concern about the impacts technology and other social media has been having on children's development. One of the most substantial concerns stems from youth displacing time that should or could be spent in productive educational activities for time spent on social media, watching TV, or playing video games (Tang & Patrick, 2018). To elaborate on this, Hunter et al. (2018) note that SB is not a significant predictor of academic achievement, but instead SB in recreational screen time compared to time spent doing homework had separate and unique relationships with academics. Additionally, the type of academic achievement you are looking at matters, as English and math outcomes each have individual relationships with SBSBs, with certain forms being more conducive to one or the other (Hunter et al., 2018). Based on this research, it is important to study the effects of different types of SB on academic achievement among children and youth.

## Pro-Social Behaviour

Pro-social behaviour has been identified as having multiple subtypes, being altruistic, proactive, and reactive (Boxer, Tisak, & Goldstein, 2004). Proactive and reactive subtypes involve acting pro-socially for personal gain or if you feel like it, which can ultimately be linked to motivation similar to aggression; whereas altruistic pro-social behaviour is a beneficial and voluntary social action towards other people or groups that involves a high degree of empathy for others (Silke, Brady, Boylan, & Dolan, 2018; Boxer et al., 2004). It includes high levels of positive and low levels of negative psychological and social skills and attitudes such as being helpful, caring, comforting, cooperative, and sharing (Guo, Wu, & Li, 2017; Lee & Carson, 2017; Silke et al., 2018). For the purpose of this study, the altruistic sub-type is the specific type of pro-social behaviour that will be assessed. There are many benefits associated with being pro-social, as when humans act in a pro-social way, it often produces a self-rewarding feeling of positive emotions, as well as fostering health, well-being, and longevity. Therefore, when people are pro-social beings, it may bring out individual strengths and promote further personal development (Guo et al., 2017). When people, especially children, are pro-social, they are more likely to have higher quality peer relationships, more social competence, lower aggression, and greater social and cognitive adjustment which in turn can affect outcomes such as academic achievement (Silke et al., 2018). Additionally, these effects were increased if the child was involved in both sports teams as well as other groups like clubs, religious affiliations, and classes (Silke et al., 2018). Interacting with other peers, especially when they may be outside of the child's usual network, can

assist the improvement of social skills such as empathy, loyalty, conflict resolution, and self-control (Lee & Carson, 2017).

Another practice that has demonstrated positive associations with pro-social behaviours is reading. Reading more than one hour per day is associated with children having a greater likelihood of exhibiting favourable social, emotional, and interactive skills (Lee & Carson, 2017). Lee and Carson (2017) explain that a reason for this may be because of the developmental benefits of children being read to by a parent or caregiver. This critical interaction between adult and child will help the young reader develop cognitively and linguistically. These skills will enable the child to express themselves better and function in diverse social situations, which are imperative to pro-social behaviour (Lee & Carson, 2017). In contrast, SBSBs such as TV viewing and video game use have been shown to have a negative association with pro-social behaviour and behavioural conduct (Carson et al., 2016a; ParticipACTION, 2018; Saunders & Vallance, 2016). Lee and Carson (2017) also found that TV viewing was not linked to social or interactive skills. Additionally, the unfavourable measures of pro-social behaviour were significantly associated with SBSB in both longitudinal and cross-sectional studies found by Carson et al. (2016a). Time spent engaging in SBSBs takes time away from doing more interactive and social activities which ultimately is shown to impede a child's pro-social abilities.

## Bullying

Bullying is when someone imposes a harmful and often aggressive behaviour on one of their peers (SHAPES-PEI, 2015). It can be in the form of a physical attack, a verbal assault, a non-verbal attack, a cyber-attack, or theft. These situations establish a

position of power for the bully, and the victim loses strength with each repeated bullying incident. Within the last decade, bullying has become more prominent than ever, as Na and Park (2018) noted that in 2009, between 6.3% and 45.2% of students in 40 different countries in the world have experienced bullying in some way, which has most-likely increased substantially since then. Bullying has emerged as one of the most common types of school-related violence and subsequently, a serious public health matter (Na & Park, 2018). These forms of abuse can cause long-term physical and psychological damage on the victim as well as immediately affect their ability to learn and engage in social interactions and physical activity (ParticipACTION, 2018; SHAPES-PEI, 2015). When male and female students were bullied on school property or skipping school due to fear of being victimized, there was an association between greater odds of playing video games and using a computer, leading to greater SB. These consequences of bullying could be affecting the child's overall health. Bullying can also affect a person's health and well-being by being associated with depression, psychological distress, poor social adjustment and problem-solving skills, and unhealthy use of alcohol, drugs, and smoking. Issues such as these tend to intensify depending on the number of ways the person is victimized, such as being bullied physically at school and electronically at home, (Demissie, Lowry, Eaton, Hertz, & Lee, 2014; Hertz, Jones, Barrios, David-Ferdon, & Holt, 2015). Although these studies highlight how bullying affects SB and other health outcomes, few studies look at how SBs impact bullying outcomes, whether it be being a bully or being a victim of bullying. However, it is a concern among many because of the recent widespread use of social media and other digital technologies. For example, Boyd and Hargittai (2013) identified that over 90% of parents of children

between the ages of 10 and 14 in a U.S. sample expressed unease about their children potentially being a victim of bullying when spending time on their digital devices. Parents tend to fear cyber bullying more than other traditional types of bullying because of the increased effort it takes to monitor the children's activity, the bullies can be anonymous, and that it can happen at all hours of the day and all months of the year (George & Odgers, 2015). Despite these adverse effects and concerns, it is not known if all forms of SB affect bullying outcomes in the same manner.

## Isotemporal Substitution

The Isotemporal Substitution Model (ISM) is a relatively new method that has been used to substitute the time spent in one activity for an equivalent time in another activity (Nagai et al., 2018). This is an important concept, as there are only 24 hours in a day, and a person can only be partaking in one of four different behaviours- sedentary behaviour, sleeping, light physical activity (LPA), or moderate-vigorous physical activity (MVPA); therefore, the change in one time-dependent behaviour will result in an equal and opposite adjustment in another (Grgic et al., 2018). This method is crucial because changing behaviour does not only produce benefits or adverse effects based on the specific activity alone, but also based on what behaviour it is displacing (Mekary, Willett, Hu, & Ding, 2009). For example, taking time in your day to read for 30 minutes not only presents the benefits found from reading but also perhaps the advantages of not watching TV for those 30 minutes. This method is different from the regularly used formula in regression models. Instead of merely adding an activity or behaviour to the model, in an ISM, a total time variable in all activities of the category is included, which, hence the name "isotemporal," enables us to interpret what happens to the other variables when one

of them is taken out of the model (Ekblom-Bak, Ekblom, Bergström, & Börjesson, 2015). Because there have been many studies including the effects of sedentary behaviour that have used a basic regression model method without the use of an ISM and its assumption that time is finite, there is a gap in the research about what specific types of sedentary behaviour cause the favourable or adverse effects on the outcomes of interest.

Further, these past studies have not considered adding total sedentary time in their models along with the specific types of SB to infer what happens when one is swapped with another. Therefore, ISM will provide us with a more intuitive and robust analysis of what happens when one hour of a sedentary activity is replaced with one hour of another. A few recent studies have adopted the ISM for sedentary behaviour and physical activity research and have gained significant results. For instance, Nagai et al. (2018) incorporated the method into their study on the effects of replacing SB with physical activity to see the changes in risk for different severities of frailty in older adults. In the crude model, they found that engaging in 30 minutes of LPA or MVPA in place of 30 minutes of SB decreased the risk of frailty in this population by 16% and 42%, respectively. However, only the effect of LPA remained significant in the adjusted model (Nagai et al., 2018). This study, along with numerous others have recently used this framework, and we hope to do the same with the SHAPES-PEI data to identify the advantages and disadvantages of different types of SB replacing one another on academic achievement, bullying, pro-social behaviour, and mental fitness. Data using ISM will enable academics and health-care professionals to collaborate on creating evidence-based guidelines and recommendations for how people should allocate their fixed time in a day to gain maximum health benefits (Grgic et al., 2018). Throughout this study, each model

of ISM will be set up to include four of the five sedentary behaviours and total sedentary time along with parental education level, sex, grade, and ethnicity as covariates. The behavioural outcome of interest will be the dependent variable of the model. An example of a model where one hour of TV is being replaced for one hour of other types of sedentary behaviours and its effect on mental fitness would resemble the following:

Mental Fitness = Computer/Video Games + Talking on the Phone + Surfing the Internet + Reading for fun + Total Sedentary Time + other covariates

## Objective and Hypothesis

Currently, there is evidence of many health and social benefits from limiting time in SB and increasing time spent in physical activity. However, because SB research is much newer, and upon review of current literature, there is still much research to be done on whether all types of sedentary behaviour are detrimental or whether some elements of SB are favourable to aspects of children's health. Specifically, there is a need to address more behavioural and mental health outcomes that are not as frequently studied in relation to sedentary behavior such as mental fitness, academic achievement, pro-social behaviour, and bullying. Furthermore, much of the current literature has used regression-based models that do not account for the total time variables like the total sedentary time variable that considers all time spent being sedentary in a day. Therefore, it is essential to incorporate the use of ISM into this research to estimate the effects of not only lessening or increasing time spent in certain sedentary behaviours but the implications of when that extra or lack of time gets allocated to other behaviours in a day. The objective of this study was to exchange one time-based sedentary behaviour with another and through the statistical method of isotemporal substitution, estimate if this swap can positively or

negatively affect the above outcomes. It was hypothesized that when one hour of the SBSBs like watching/streaming TV shows or movies, playing video/computer games, and surfing the internet, is replaced with one hour of the NSBSBs such as reading for fun and talking on the phone, there will be positive associations found with greater mental fitness, less bullying or being bullied, higher academic achievement, and superior pro-social behaviour.

## METHODS

### Participants and Study Design

The present study consisted of a secondary analysis of cross-sectional data from a sample of existing participants from the SHAPES-PEI survey. SHAPES-PEI is a survey conducted and funded through a partnership with the Comprehensive School Health Research (CSHR) Group at the University of Prince Edward Island, the PEI Department of Education and Early Childhood Development, the PEI Department of Health and Wellness, the PEI Healthy Eating Alliance, and Go! PEI. It measured influential health-behaviors in students from 53 schools across PEI in grades 5-12. This information was collected in response to a need for more health-related data at the individual school level in PEI in order to identify trends for policy, planning, and to develop strategies for interventions. The questionnaire was administered biennially, which started in 2008-2009, to more than 5,000 students each cycle, resulting in self-reported data from a sample of more than 50% of students in this age group. Data for each period was collected between November and April of the academic year. All schools in PEI participated in the SHAPES-PEI survey except for those that fit the exclusion criteria of being federally funded such as schools on First Nations Reserves, schools for children with special needs, schools with fewer than 20 children in the eligible grades, and schools that did not contain at least one grade in the survey range (i.e. 5-12). The sampling method of questionnaires was as follows:

- Grade 5; All students were asked to complete a SHAPES-PEI questionnaire.
- Grade 6; Two-thirds of the students were randomly assigned a SHAPES-PEI survey, while one third were assigned a CSTADS Module A questionnaire.

- Grade 7 to 12; Two-thirds of the students were randomly assigned a SHAPES-PEI survey, while one third was assigned a CSTADS Module B questionnaire.

Surveys were administered during class time by a teacher, and the instructions from the SHAPES-PEI research team were communicated to the students. At least one member of the research team was present at each school during data collection. Surveys were administered in both English and French as required. Students with disabilities and/or English as a second language were eligible to participate at the discretion of the school administration and staff. Each student sealed his or her survey in an envelope. Then class sets of completed surveys were sealed in a larger envelope and transported back to UPEI for packaging. The questionnaires were forwarded to Propel at the University of Waterloo, and there, data-files were created for SHAPES-PEI researchers. The 2014-2015 cycle was analyzed for the present study because it is the most recent cycle and it contributed the most detailed data about sedentary behaviour. The 2014-2015 period included 5621 total participants, with 2766 boys and 2855 girls all between grades 5-12. The data of interest from the study included sedentary behaviours, mental fitness, academic achievement, pro-social behaviour, and bullying. The data was formatted into a useable form compatible with SPSS statistics software by the research group. Total sedentary behaviour time of each participant was calculated by summing the self-reported time from each participant in time spent watching/streaming TV shows or movies, playing video/computer games, talking on the phone, surfing the internet, and reading for fun.

## Ethics

Ethics for the original research was received from the UPEI Research Ethics Board for the Comprehensive School Health Research (CSHR) Group. Because the PEI provincial school board underwent many structural changes throughout the course of the SHAPES-PEI data collection, there were multiple processes to obtain the school board consent. However, for the 2014/2015 cycle, the English Language School required that researchers obtain written consent from the board superintendent for permission to conduct research within their schools. The superintendent of La Commission Scolaire de la Langue Française also gave written consent for the study. For children under the age of 14, active information with active consent was used, meaning that a parent or guardian signed and returned a form if they consented for their child to participate in the study. For participants 14 years of age or older, active information with passive consent was used, which only required parents or guardians to sign and return a form if they refused to allow their child to participate (Range, Embry, & MacLeod, 2001). The main difference being that it was assumed that the parent or guardian of older children have consented unless some action is taken, and younger children needed the written permission of their parent to participate in the study. Regardless, when the survey was handed out, the students were reminded that their participation was voluntary, and they did not have to answer any questions that they did not feel comfortable answering or did not want to answer. Their active agreement to participate was considered their assent.

## Dependent Variables

The four health behaviours of interest in relation to various sedentary behaviours included mental fitness, academic achievement, pro-social behaviour, and bullying. The

mental fitness data was collected using questions from the Children's Intrinsic Needs Satisfaction Scale (CINSS) by Koestner and Véronneau (2001) with 18 questions such as "I feel I do things well at school" and "My teachers like me and care about me" each on a scale of 1-4 with one being "really false for me" and four being "really true for me." Each of the questions assessed one of the three intrinsic needs necessary for well-being-autonomy, competence, and relatedness. Each student's mental fitness score was derived by adding up the scores of each participant. Based on the derivation criteria of the SHAPES-PEI team, those who answered nine or more of the questions received a valid response and a score of either low ($\geq$18, $\leq$46), medium (>46, <56), or high ($\geq$56, $\leq$72) mental fitness. These scores were then further dichotomized into two categories. One being low mental fitness and two being either medium or high mental fitness.

The data forming the academic achievement outcomes consisted of a combination of both their most recent Math and English course grades. Students answered two identical questions: "In your current or most recent (Math and English) course, what is your approximate overall mark?" and could answer on a scale of 1-7, with one being 90%-100% and seven being less than 50%. Separately, these values for each course grade were dichotomized into two categories, the first being any grades lower than 80% and the second being any grades equal to or greater than 80%. This cut-off was consistent with most Honour Rolls in High-Schools in Canada as well as was the same method used in a similar study by Hunter et al. (2018).

The pro-social behaviour outcome was derived from five questions from the Altruistic Pro-social Behaviour subscale on the Aggressive and Pro-social Behaviour Questionnaire by Boxer et al. (2004) such as "I often do favours for people without being

asked." Students were able to answer on a scale ranging from 1-6, where one was "definitely not like me" and six was "definitely like me." These scores were added and divided by the number of questions answered (minimum of three) then multiplied by ten to receive an overall rating for pro-social behaviour, with all possible scores being between 10 and 60. This data was then dichotomized into two groups split right in the middle at a score of 35, with "low" being ($\geq$10, $<$34.9) and "high" being ($\geq$34.9, $\leq$60).

Lastly, the bullying data came from the questions concerning how often and in what ways did you get bullied and bully others in the past 30 days. The questions included "In the last 30 days, how often have you been bullied by other students" and "In the last 30 days, how often did you bully other students." Students were able to answer on scales of 1-5 with one being "I have not been bullied by other students/bullied other students in the last 30 days" and five being "daily or almost daily." These answers were dichotomized into two categories. The first category was never being bullied or bullying others in the last 30 days, and the other was being bullied or bullying others at all in any capacity (from less than once a week to daily or almost daily) in the last 30 days. Furthermore, the types of bullying analyzed included cyber-attack, non-verbal attack, verbal attack, and physical attack including both being bullied by others and bullying others. These categories were dichotomized into two categories of simply "yes" or "no" for experiencing these behaviours in the past 30 days.

## Independent Variables

Each of the independent variables inserted into the ISM included the five sedentary behaviours of interest in the study, being watching/streaming TV shows or movies, playing video/computer games, talking on the phone, surfing the internet, and

reading for fun. Each of the behaviours was calculated by taking the answers to the question from the survey that asked for each behaviour separately, "On average, about how many hours a day do you do the following?" Students were able to respond with one of the following options: None, less than one hour a day, one to two hours a day, more than two but less than five hours a day, or five or more hours a day. Due to the categorical nature of the hours for each available answer, the average of each option was recoded for the purposes of this analysis. For example, none became 0 h, less than one became 0.5 h, one to two became 1.5 h, more than two but less than five became 3.5 h, and five or more became 5h. Each sedentary behaviour was recoded as well as summed together to create a new variable for total sedentary time.

## Statistical Analyses

All data were analyzed using SPSS v 23.0 (IBM Corp, Armonk, USA). The Isotemporal Substitution Method was carried out through a log-binomial regression in a generalized linear model to estimate the effects on variables such as mental fitness, academic achievement, pro-social behaviour, and bullying when different sedentary activities were substituted with other sedentary activities for the same amount of time. This evaluated not only the impact of specific behaviours but also the impact of the activity it is displacing. These tests were run for all participants as well as for boys and girls separately. Each model included four of the five sedentary behaviours and total sedentary behaviour time while also controlling for grade, sex, parental education level, and ethnicity as covariates. Each of the specific health outcomes mentioned above were the dependent variables in the models.

## RESULTS

Descriptive characteristics of study participants were analyzed and are presented in Table 1. Participants reported accumulating 5.46 hours/day of total sedentary behaviour and 4.02 hours/day of total screen time. Based on the nature of the abnormally distributed data, no significance testing was conducted between boys' and girls' responses. However, upon visual inspection, differences in sedentary behaviours were generally small between boys and girls, although boys had much higher time spent playing computer and/or video games (1.71 vs. 0.58 hours/day), and girls had increased times in the rest of the behaviours, most notably surfing the internet (1.5 vs. 1.14 hours/day) and reading for fun (1.36 vs. 0.72). Nevertheless, boys reported both higher total screen time and entire sedentary time per day (4.34 vs. 3.72) and (5.48 vs. 5.44) respectively.

Table 1. Descriptive Statistics of Participants.

| | All participants (n=5621) | Boys (n=2766) | Girls (n=2855) |
|---|---|---|---|
| **Grade** | **%** | **%** | **%** |
| 5 | 17.5 | 17.2 | 17.8 |
| 6 | 11.0 | 10.7 | 11.2 |
| 7 | 10.6 | 10.6 | 10.6 |
| 8 | 9.0 | 8.7 | 9.4 |
| 9 | 12.7 | 12.4 | 13.0 |
| 10 | 14.1 | 14.5 | 13.7 |
| 11 | 12.6 | 12.5 | 12.6 |
| 12 | 12.6 | 13.3 | 11.8 |
| | | | |
| **Ethnicity** | | | |
| White | 86.6 | 85.2 | 88.9 |
| Other | 12.4 | 13.9 | 11.1 |
| | | | |
| **Mother's Education** | | | |
| Less than high school | 3.1 | 2.7 | 3.5 |
| High school | 14.3 | 14.8 | 13.9 |
| College | 19.7 | 18.3 | 21.2 |

| | | | |
|---|---|---|---|
| University | 40.0 | 39.7 | 40.2 |
| I don't know | 21.4 | 22.9 | 19.9 |
| | | | |
| **Father's Education** | | | |
| Less than high school | 7.2 | 6.4 | 8.0 |
| High school | 17.6 | 18.2 | 16.9 |
| College | 18.8 | 18.8 | 18.7 |
| University | 28.3 | 28.5 | 28.0 |
| I don't know | 26.4 | 25.9 | 26.8 |
| | | | |
| **Study Outcomes** | | | |
| Low Mental Fitness | 7.7 | 8.5 | 7.0 |
| Medium/High Mental Fitness | 90.5 | 89.2 | 91.7 |
| Low Academic Achievement Math | 28.2 | 30.0 | 26.4 |
| High Academic Achievement Math | 52.8 | 51.3 | 54.2 |
| Low Academic Achievement English | 24.5 | 31.8 | 17.4 |
| High Academic Achievement English | 54.6 | 47.5 | 61.4 |
| Low Pro-social Behaviour | 50.9 | 58.5 | 43.4 |
| High Pro-social Behaviour | 46.5 | 38.1 | 54.6 |
| Was Bullied by Others in past 30 days | 26.5 | 23.6 | 29.5 |
| Was Not Bullied by Others in past 30 days | 69.3 | 71.2 | 67.4 |
| Did Bully Others in the past 30 days | 11.5 | 13.6 | 9.5 |
| Did Not Bully Others in the past 30 days | 85.1 | 82.4 | 87.8 |
| | | | |
| **Sedentary Behaviours** | | | |
| | M (SD) | M (SD) | M (SD) |
| TV (hrs/day) | 1.62 (1.30) | 1.55 (1.29) | 1.69 (1.31) |
| Video/computer games (hrs/day) | 1.13 (1.46) | 1.71 (1.59) | 0.581 (1.06) |
| Talking on the phone (hrs/day) | 0.54 (1.00) | 0.46 (0.88) | 0.62(1.09) |
| Internet (hrs/day) | 1.33 (1.47) | 1.14 (1.36) | 1.50 (1.55) |

| | | | |
|---|---|---|---|
| Reading (hrs/day) | 0.94 (1.24) | 0.72 (1.09) | 1.36 (1.34) |
| Total Sedentary behaviour (hrs/day) | 5.46 (3.54) | 5.48 (3.65) | 5.44 (3.43) |
| Total Screen Time (hrs/day) | 4.02 (2.90) | 4.34 (3.06) | 3.72 (2.70) |

Table 2. ISM results for assessing the relative risk of having low mental fitness.

| | All participants | | Boys | | Girls | |
|---|---|---|---|---|---|---|
| | RR (95% CI) | P value | RR (95% CI) | P value | RR (95% CI) | P value |
| Replacing TV with: | n=5074 | | n=2458 | | n=2616 | |
| Computer/ Video Games | 1.16 (1.06, 1.27) | <.01 | 1.04 (.91, 1.18) | .59 | 1.25 (1.07, 1.45) | <.01 |
| Talking on Phone | 1.13 (1.02, 1.26) | .02 | 1.06 (.91, 1.23) | .45 | 1.19 (1.04, 1.36) | .01 |
| Surfing Internet | 1.17 (1.06, 1.30) | <.01 | 1.03 (.89, 1.19) | .72 | 1.33 (1.15, 1.53) | <.01 |
| Reading for Fun | .94 (.84, 1.05) | .24 | .78 (.66, .93) | .01 | 1.08 (.94, 1.23) | .27 |
| Replace Computer/ Video Games with: | n=5086 | | n=2463 | | n=2623 | |
| TV | .87 (.79, .95) | <.01 | .96 (.84, 1.09) | .52 | .81 (.70, .95) | .01 |
| Talking on the Phone | .98 (.90, 1.07) | .61 | 1.02 (.90, 1.15) | .81 | .96 (.82, 1.11) | .55 |
| Surfing Internet | 1.01 (.93, 1.11) | .78 | .99 (.86, 1.14) | .86 | 1.07 (.94, 1.22) | .32 |
| Reading for Fun | .81 (.74, .90) | <.01 | .75 (.64, .88) | <.01 | .88 (.74, 1.04) | .13 |
| Replace talking on the phone with: | n=5111 | | n=2481 | | n=2630 | |
| TV | .88 (.80, .98) | .02 | .94 (.81, 1.09) | .40 | .85 (.75, .97) | .02 |
| Computer/ Video Games | 1.02 (.93, 1.11) | .70 | .97 (.86, 1.10) | .65 | 1.06 (.91, 1.22) | .48 |
| Surfing Internet | 1.03 (.94, 1.14) | .52 | .96 (.84, 1.11) | .60 | 1.13 (.98, 1.29) | .10 |
| Reading for fun | .83 (.75, .92) | <.01 | .73 (.62, .86) | <.01 | .93 (.81, 1.06) | .26 |
| Replace internet with: | n=5104 | | n=2474 | | n=2630 | |
| TV | .86 (.78, .96) | .01 | .99 (.85, 1.15) | .92 | .75 (.65, .86) | <.01 |
| Computer/Video Games | .99 (.91, 1.09) | .89 | 1.02 (.88, 1.18) | .80 | .94 (.82, 1.07) | .32 |
| Talking on the Phone | .97 (.88, 1.07) | .59 | 1.05 (.91, 1.21) | .52 | .89 (.77, 1.02) | .09 |
| Reading for Fun | .81 (.73, .89) | <.01 | .78 (.67, .91) | <.01 | .81 (.70, .93) | <.01 |
| Replace reading with: | n=5078 | | n=2459 | | n=2619 | |
| TV | 1.07 (.96, 1.19) | .25 | 1.28 (1.08, 1.53) | .01 | .93 (.81, 1.06) | .26 |
| Computer/Video Games | 1.24 (1.12, 1.37) | <.01 | 1.33 (1.14, 1.55) | <.01 | 1.16 (.98, 1.37) | .09 |
| Talking on the Phone | 1.21 (1.09, 1.34) | <.01 | 1.36 (1.16, 1.59) | <.01 | 1.10 (.96, 1.26) | .16 |
| Surfing the internet | 1.25 (1.13, 1.38) | <.01 | 1.32 (1.13, 1.54) | <.01 | 1.23 (1.07, 1.42) | <.01 |

Table 3. ISM results for assessing the relative risk of having low (a grade of less than 80%) academic achievement in Math.

| | All participants | | Boys | | Girls | |
|---|---|---|---|---|---|---|
| | RR (95% CI) | P value | RR (95% CI) | P value | RR (95% CI) | P value |
| Replacing TV with: | n=4239 | | n=2064 | | n=2175 | |
| Computer/ Video Games | 1.00 (.96, 1.05) | .89 | 1.03 (.96, 1.10) | .46 | .94 (.85, 1.01) | .08 |
| Talking on Phone | .98 (.94, 1.03) | .40 | .98 (.91, 1.06) | .67 | .97 (.92, 1.03) | .31 |
| Surfing Internet | 1.07 (1.02, 1.11) | <.01 | 1.08 (1.01, 1.15) | .02 | 1.04 (.98, 1.11) | .17 |
| Reading for Fun | .88 (.84, .93) | <.01 | .87 (.80, .94) | <.01 | .88 (.83, .94) | <.01 |
| Replace Computer/ Video Games with: | n=4250 | | n=2067 | | n=2183 | |
| TV | 1.00 (.95, 1.05) | .96 | .98 (.92, 1.04) | .49 | 1.07 (.99, 1.16) | .08 |
| Talking on the Phone | .98 (.94, 1.02) | .31 | .97 (.91, 1.03) | .27 | 1.04 (.96, 1.11) | .34 |
| Surfing Internet | 1.06 (1.02, 1.11) | <.01 | 1.06 (.99, 1.13) | .11 | 1.12 (1.05, 1.19) | <.01 |
| Reading for Fun | .88 (.84, .93) | <.01 | .85 (.78, .92) | <.01 | .95 (.88, 1.03) | .19 |
| Replace talking on the phone with: | n=4271 | | n=2085 | | n=2186 | |
| TV | 1.02 (.97, 1.07) | .39 | 1.02 (.94, 1.10) | .66 | 1.03 (.97, 1.09) | .31 |
| Computer/ Video Games | 1.02 (.98, 1.07) | .31 | 1.04 (.98, 1.11) | .23 | .96 (.90, 1.04) | .31 |
| Surfing Internet | 1.09 (1.04, 1.14) | <.01 | 1.10 (1.03, 1.18) | .01 | 1.08 (1.01, 1.14) | .02 |
| Reading for fun | .90 (.86, .94) | <.01 | .88 (.82, .95) | <.01 | .91 (.86, .97) | <.01 |
| | | | | | | |
| Replace internet with: | n=4259 | | n=2075 | | n=2184 | |
| TV | .94 (.90, .98) | .01 | .94 (.88, 1.00) | .04 | .95 (.90, 1.01) | .12 |
| Computer/Video Games | .94 (.91, .98) | .01 | .96 (.90, 1.02) | .20 | .90 (.84, .95) | <.01 |
| Talking on the Phone | .92 (.88, .97) | <.01 | .92 (.86, .99) | .02 | .93 (.87, .99) | .02 |
| Reading for Fun | .83 (.79, .87) | <.01 | .81 (.75, .88) | <.01 | .85 (.79, .90) | <.01 |
| Replace reading with: | n=4240 | | n=2064 | | n=2176 | |
| TV | 1.14 (1.08, 1.19) | <.01 | 1.15 (1.06, 1.25) | <.01 | 1.13 (1.06, 1.20) | <.01 |
| Computer/Video Games | 1.14 (1.08, 1.20) | <.01 | 1.18 (1.09, 1.29) | <.01 | 1.06 (.98, 1.14) | .16 |
| Talking on the Phone | 1.12 (1.06, 1.17) | <.01 | 1.14 (1.05, 1.23) | <.01 | 1.10 (1.04, 1.17) | <.01 |
| Surfing the internet | 1.21 (1.15, 1.27) | <.01 | 1.25 (1.15, 1.35) | <.01 | 1.18 (1.11, 1.26) | <.01 |

Table 4. ISM results for assessing the relative risk of having low (a grade of less than 80%) academic achievement in English.

| | All participants | | Boys | | Girls | |
|---|---|---|---|---|---|---|
| | RR (95% CI) | P value | RR (95% CI) | P value | RR (95% CI) | P value |
| Replacing TV with: | n=4150 | | n=2018 | | n=2132 | |
| Computer/ Video Games | 1.11 (1.05, 1.16) | <.01 | 1.04 (.97, 1.11) | .30 | .99 (.89, 1.10) | .82 |
| Talking on Phone | 1.03 (.97, 1.09) | .29 | 1.05 (.97, 1.13) | .25 | 1.00 (.91, 1.09) | .95 |
| Surfing Internet | 1.01 (.96, 1.06) | .67 | 1.01 (.95, 1.08) | .76 | 1.04 (.95, 1.14) | .40 |
| Reading for Fun | .84 (.79, .90) | <.01 | .87 (.79, .95) | <.01 | .84 (.77, .92) | <.01 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Replace Computer/ Video Games with: | n=4161 | | n=2021 | | n=2140 | |
| TV | .90 (.86, .95) | <.01 | .97 (.90, 1.03) | .29 | 1.01 (.91, 1.12) | .86 |
| Talking on the Phone | .93 (.89, .97) | <.01 | 1.01 (.95, 1.08) | .74 | 1.00 (.92, 1.10) | .94 |
| Surfing Internet | .91 (.87, .96) | <.01 | .98 (.92, 1.04) | .45 | 1.05 (.96, 1.14) | .26 |
| Reading for Fun | .76 (.71, .80) | <.01 | .84 (.77, .91) | <.01 | .85 (.76, .94) | <.01 |
| Replace talking on the phone with: | n=4180 | | n=2037 | | n=2143 | |
| TV | .97 (.91, 1.02) | .24 | .95 (.88, 1.03) | .21 | 1.00 (.92, 1.09) | .99 |
| Computer/ Video Games | 1.07 (1.03, 1.12) | <.01 | .99 (.93, 1.05) | .47 | .99 (.91, 1.08) | .80 |
| Surfing Internet | .98 (.93, 1.03) | .44 | .96 (.90, 1.04) | .31 | 1.04 (.96, 1.13) | .35 |
| Reading for fun | .81 (.77, .86) | <.01 | .83 (.77, .90) | <.01 | .84 (.77, .91) | <.01 |
| | | | | | | |
| Replace internet with: | n=4168 | | n=2029 | | n=2139 | |
| TV | .99 (.94, 1.04) | .60 | .99 (.93, 1.05) | .72 | .96 (.88, 1.05) | .36 |
| Computer/Video Games | 1.09 (1.04, 1.14) | <.01 | 1.02 (.96, 1.08) | .55 | .95 (.88, 1.04) | .27 |
| Talking on the Phone | 1.02 (.96, 1.07) | .58 | 1.03 (.96, 1.10) | .44 | .96 (.89, 1.04) | .35 |
| Reading for Fun | .83 (.78, .88) | <.01 | .85 (.79, .93) | <.01 | .81 (.74, .89) | <.01 |
| Replace reading with: | n=4151 | | n=2018 | | n=2133 | |
| TV | 1.19 (1.12, 1.27) | <.01 | 1.15 (1.0, 1.26) | <.01 | 1.19 (1.08, 1.30) | <.01 |
| Computer/Video Games | 1.32 (1.24, 1.40) | <.01 | 1.20 (1.10, 1.30) | <.01 | 1.18 (1.06, 1.30) | <.01 |
| Talking on the Phone | 1.23 (1.16, 1.30) | <.01 | 1.21 (1.12, 1.32) | <.01 | 1.19 (1.09, 1.29) | <.01 |
| Surfing the internet | 1.21 (1.13, 1.28) | <.01 | 1.17 (1.07, 1.27) | <.01 | 1.24 (1.13, 1.36) | <.01 |

Table 5. ISM results for assessing the relative risk of having low altruistic pro-social behaviour.

| | All participants | | Boys | | Girls | |
|---|---|---|---|---|---|---|
| | RR (95% CI) | P value | RR (95% CI) | P value | RR (95% CI) | P value |
| Replacing TV with: | n=5040 | | n=2437 | | n=2603 | |
| Computer/ Video Games | 1.11 (1.07, 1.16) | <.01 | 1.05 (.99, 1.10) | .09 | 1.08 (1.01, 1.17) | .03 |
| Talking on Phone | .95 (.91, 1.00) | <.01 | .94 (.88, 1.00) | .05 | .96 (.90, 1.03) | .30 |
| Surfing Internet | 1.01 (.97,1.05) | .05 | 1.00 (.95, 1.05) | .99 | 1.03 (.96, 1.11) | .38 |
| Reading for Fun | .88 (.84, .92) | .77 | .86 (.81, .92) | <.01 | .92 (.86, .99) | .02 |
| Replace Computer/ Video Games with: | N=5052 | | n=2442 | | n=2610 | |
| TV | .90 (.87, .93) | <.01 | .96 (.91, 1.01) | .08 | .92 (.86, .99) | .04 |
| Talking on the Phone | .86 (.82, .89) | <.01 | .89 (.85, .94) | <.01 | .89 (.83, .95) | <.01 |
| Surfing Internet | .91 (.87, .94) | <.01 | .96 (.91, 1.00) | .07 | .96 (.89, 1.02) | .18 |
| Reading for Fun | .79 (.76, .83) | <.01 | .82 (.77, .88) | <.01 | .85 (.79, .91) | <.01 |
| Replace talking on the phone with: | N=5077 | | n=2460 | | n=2617 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| TV | 1.05 (1.00, 1.10) | .06 | 1.07 (1.00, 1.14) | .05 | 1.03 (.96, 1.11) | .36 |
| Computer/ Video Games | 1.17 (1.12, 1.21) | <.01 | 1.12 (1.06, 1.18) | <.01 | 1.12 (1.05, 1.20) | <.01 |
| Surfing Internet | 1.06 (1.01, 1.11) | .03 | 1.07 (1.01, 1.14) | .03 | 1.07 (1.00, 1.15) | .07 |
| Reading for fun | .92 (.88, .97) | <.01 | .92 (.86, .99) | .03 | .95 (.88, 1.02) | .17 |
| | | | | | | |
| Replace internet with: | N=5069 | | n=2453 | | n=2616 | |
| TV | .99 (.95, 1.03) | .75 | 1.00 (.95, 1.05) | .99 | .97 (.90, 1.04) | .35 |
| Computer/Video Games | 1.10 (1.07, 1.14) | <.01 | 1.04 (.99, 1.09) | .10 | 1.05 (.98, 1.12) | .17 |
| Talking on the Phone | .95 (.91, .99) | .02 | .94 (.88, .99) | .03 | .94 (.87, 1.01) | .07 |
| Reading for Fun | .87 (.84, .91) | <.01 | .86 (.80, .91) | <.01 | .89 (.84, .94) | <.01 |
| Replace reading with: | N=5042 | | n=2438 | | n=2604 | |
| TV | 1.13 (1.08, 1.19) | <.01 | 1.16 (1.09, 1.24) | <.01 | 1.09 (1.02, 1.16) | .02 |
| Computer/Video Games | 1.26 (1.21, 1.32) | <.01 | 1.21 (1.14, 1.29) | <.01 | 1.18 (1.10, 1.27) | <.01 |
| Talking on the Phone | 1.08 (1.03, 1.14) | <.01 | 1.09 (1.01, 1.17) | .02 | 1.05 (.97, 1.13) | .23 |
| Surfing the internet | 1.14 (1.09, 1.19) | <.01 | 1.16 (1.09, 1.24) | <.01 | 1.13 (1.06, 1.20) | <.01 |

Table 6. ISM results for assessing the relative risk of having been bullied by others at all in the past 30 days.

| | All participants | | Boys | | Girls | |
|---|---|---|---|---|---|---|
| | RR (95% CI) | P value | RR (95% CI) | P value | RR (95% CI) | P value |
| Replacing TV with: | n=4965 | | n=2395 | | n=2570 | |
| Computer/ Video Games | .97(.92, 1.02) | .26 | 1.01 (.93, 1.09) | .90 | .98 (.91, 1.05) | .53 |
| Talking on Phone | 1.08 (1.03, 1.14) | <.01 | 1.03 (.93, 1.13) | .59 | 1.11 (1.04, 1.18) | <.01 |
| Surfing Internet | 1.06 (1.01, 1.12) | .02 | .99 (.91, 1.08) | .87 | 1.09 (1.02, 1.16) | .01 |
| Reading for Fun | 1.05 (1.00, 1.10) | .05 | 1.02 (.94, 1.11) | .68 | 1.06 (1.00, 1.13) | .04 |
| | | | | | | |
| Replace Computer/ Video Games with: | n=4977 | | n=2400 | | n=2577 | |
| TV | 1.03 (.98, 1.09) | .25 | .99 (.91, 1.08) | .84 | 1.03 (.96, 1.11) | .45 |
| Talking on the Phone | 1.11 (1.06, 1.17) | <.01 | 1.02 (.94, 1.10) | .73 | 1.14 (1.06, 1.22) | <.01 |
| Surfing Internet | 1.09 (1.04, 1.15) | <.01 | .98 (.90, 1.07) | .72 | 1.11 (1.04, 1.19) | <.01 |
| Reading for Fun | 1.08 (1.03, 1.13) | <.01 | 1.01 (.94, 1.09) | .79 | 1.09 (1.02, 1.18) | .02 |
| | | | | | | |
| Replace talking on the phone with: | n=5001 | | n=2418 | | n=2583 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| TV | .93 (.88, .98) | <.01 | .98 (.89, 1.07) | .63 | .90 (.85, .96) | <.01 |
| Computer/ Video Games | .90 (.85, .94) | <.01 | .98 (.90, 1.07) | .64 | .88 (.82, .94) | <.01 |
| Surfing Internet | .98 (.93, 1.03) | .40 | .97 (.88, 1.06) | .47 | .98 (.92, 1.04) | .42 |
| Reading for fun | .97 (.93, 1.02) | .20 | 1.00 (.92, 1.08) | .90 | .96 (.91, 1.01) | .13 |
| | | | | | | |
| Replace internet with: | n=4993 | | n=2409 | | n=2584 | |
| TV | .94 (.90, .99) | .03 | 1.01 (.93, 1.10) | .83 | .92 (.87, .98) | .01 |
| Computer/Video Games | .92 (.87, .96) | <.01 | 1.01 (.93, 1.10) | .78 | .90 (.84, .96) | <.01 |
| Talking on the Phone | 1.02 (.97, 1.07) | .47 | 1.04 (.95, 1.14) | .41 | 1.02 (.96, 1.08) | .58 |
| Reading for Fun | .99 (.95, 1.04) | .70 | 1.03 (.95, 1.12) | .44 | .98 (.93, 1.04) | .47 |
| Replace reading with: | n=4968 | | n=2395 | | n=2573 | |
| TV | .95 (.91, 1.00) | .05 | .98 (.90, 1.07) | .66 | .94 (.89, 1.00) | .04 |
| Computer/Video Games | .92 (.88, .97) | <.01 | .99 (.92, 1.06) | .76 | .92 (.85, .99) | .02 |
| Talking on the Phone | 1.03 (.98, 1.08) | .22 | 1.01 (.93, 1.09) | .87 | 1.04 (.99, 1.10) | .15 |
| Surfing the internet | 1.01 (.97, 1.06) | .61 | .98 (.90, 1.06) | .55 | 1.02 (.97, 1.08) | .49 |

Table 7. ISM results for assessing the relative risk of having bullied others at all in the past 30 days.

| | All participants | | Boys | | Girls | |
|---|---|---|---|---|---|---|
| | RR (95% CI) | P value | RR (95% CI) | P value | RR (95% CI) | P value |
| Replacing TV with: | n=5010 | | n=2423 | | n=2587 | |
| Computer/ Video Games | 1.03 (.96, 1.11) | .41 | .95 (.85, 1.06) | .38 | 1.04 (.92, 1.19) | .51 |
| Talking on Phone | 1.08 (.99, 1.17) | .08 | 1.17 (1.04, 1.30) | .01 | .99 (.88, 1.12) | .90 |
| Surfing Internet | 1.06 (.98, 1.14) | .17 | .99 (.89, 1.10) | .82 | 1.17 (1.04, 1.33) | .01 |
| Reading for Fun | .85 (.77, .93) | <.01 | .80 (.69, .91) | <.01 | .91 (.81, 1.03) | .14 |
| | | | | | | |
| Replace Computer/ Video Games with: | n=5023 | | n=2428 | | n=2595 | |
| TV | .97 (.90, 1.05) | .46 | 1.05 (.94, 1.16) | .43 | .97 (.85, 1.10) | .62 |
| Talking on the Phone | 1.04 (.97, 1.11) | .27 | 1.21 (1.11, 1.32) | <.01 | .96 (.84, 1.09) | .50 |
| Surfing Internet | 1.02 (.95, 1.10) | .52 | 1.03 (.93, 1.15) | .56 | 1.13 (1.00, 1.27) | .05 |
| Reading for Fun | .82 (.75, .90) | <.01 | .83 (.73, .95) | .01 | .88 (.77, 1.02) | .10 |

| Replace talking on the phone with: | n=5047 | | n=2446 | | n=2601 | |
|---|---|---|---|---|---|---|
| TV | .93 (.86, 1.01) | .08 | .86 (.77, .96) | .01 | 1.01 (.89, 1.13) | .94 |
| Computer/ Video Games | .96 (.89, 1.02) | .20 | .81 (.74, .89) | <.01 | 1.05 (.92, 1.19) | .52 |
| Surfing Internet | .98 (.90, 1.06) | .62 | .85 (.76, .94) | <.01 | 1.18 (1.04, 1.33) | .01 |
| Reading for fun | .78 (.72, .85) | <.01 | .68 (.60, .77) | <.01 | .91 (.81, 1.03) | .13 |

| Replace internet with: | n=5039 | | n=2438 | | n=2601 | |
|---|---|---|---|---|---|---|
| TV | .94 (.87, 1.02) | .12 | 1.00 (.90, 1.11) | .96 | .85 (.75, .96) | .01 |
| Computer/Video Games | .97 (.90, 1.04) | .40 | .95 (.86, 1.06) | .34 | .89 (.79, 1.00) | .04 |
| Talking on the Phone | 1.01 (.93, 1.09) | .90 | 1.16 (1.05, 1.29) | <.01 | .84 (.74, .95) | <.01 |
| Reading for Fun | .79 (.73, .87) | <.01 | .79 (.70, .90) | <.01 | .77 (.66, .87) | <.01 |
| Replace reading with: | n=5014 | | n=2423 | | n=2591 | |
| TV | 1.18 (1.08, 1.12) | <.01 | 1.26 (1.10, 1.44) | <.01 | 1.09 (.97, 1.24) | .15 |
| Computer/Video Games | 1.22 (1.12, 1.33) | <.01 | 1.20 (1.05, 1.37) | .01 | 1.14 (.99, 1.32) | .07 |
| Talking on the Phone | 1.27 (1.16, 1.38) | <.01 | 1.46 (1.29, 1.66) | <.01 | 1.09 (.97, 1.22) | .17 |
| Surfing the internet | 1.25 (1.14, 1.36) | <.01 | 1.24 (1.09, 1.41) | <.01 | 1.29 (1.14, 1.45) | <.01 |

After completing the Isotemporal Substitutions for each outcome and their specific subcategories, 14 tables were created with the results of each Generalized Linear Model and the relative risk, 95% confidence interval, and p-value for each outcome and sedentary behaviour.

## Mental Fitness

As for mental fitness (Table 2), when looking at all participants together and boys separately, reading for fun was the SB most positively associated with having high mental fitness when it was swapped instead of all other SBs. On the other hand, TV was the best SB when replacing it with another behaviour for girls, and the majority answer of surfing the internet was the worst for all participants and girls separately, as when girls swapped TV with internet, they were 33% more likely to have low mental fitness. Whereas for boys, talking on the phone was estimated as being the most detrimental to

mental fitness as it shows that when replacing one hour of reading with one hour of talking on the phone, boys were 36% more likely to exhibit low mental fitness.

## Academic Achievement

Academic achievement in both Math and English (Tables 3 and 4) were highly related to reading, as when reading for fun was replaced by any other SB, all participants and boys and girls separately were more likely to have a grade lower than 80%. Specifically, when all participants replaced reading with computer/video games, they were 32% more likely to have an English grade of less than 80%. For academic achievement in math for all participants and boys and girls separately, surfing the internet was estimated as being the worst SB when it replaced any other SB. While talking on the phone was the worst SB for academic success in English for boys and surfing the internet remained the lowest for English grade for girls. However, computer/video games were estimated as the overall worst SB on average for all participants for English grades.

## Pro-Social Behaviour

Altruistic pro-social behaviour (Table 5) also demonstrated the highest association with reading when it came to having high pro-social behaviour for all participants and boys and girls separately. Additionally, computer/video games were consistently related to being the least optimal SB for altruistic pro-social behaviour among all participants and boys and girls individually.

## Bullying

When it comes to being bullied by others (Table 6), for all participants and girls separately, computer and video games were associated with being the best SB as it showed the least likelihood of being bullied by others when replacing it with all other

behaviours. For boys, surfing the internet was the favourable behaviour for not being intimidated by others. Talking on the phone consistently remained the least beneficial behaviour for all participants together and both genders.

Looking at the other side of bullying (Table 7), when all participants and boys and girls individually, replaced reading with any other SB, they were more likely to bully others. Once again, talking on the phone, rather than engaging in any of the other SBs, was associated highest with bullying others among all participants and boys. Significantly, when boys replaced reading with talking on the phone, they were 46% more apt to bully others. Furthermore, girls exhibited surfing the internet as the SB associated with being the most likely to bully others, as when it was replaced with any other behaviour, they were less likely to bully others.

Other specific forms of bullying- physical, verbal, non-verbal, and cyber-attacks in both the context of being bullied and bullying others, were also analyzed; however, for the purpose of this study, only cyber-bullying was of interest (see Appendix for tables 8 and 9) and the same general effects, including some highly significant findings, to the above outcomes of bullying were observed.

## DISCUSSION

The purpose of this study was to use the statistical method of isotemporal substitution to exchange one time-based sedentary behaviour with another to estimate if this time-based behaviour replacement can positively or negatively affect mental fitness, academic achievement, altruistic pro-social behaviour, and bullying outcomes. Our hypothesis was partially supported, as the NSBSB of reading for fun was most commonly the most favourable SB for all dependent variables. Additionally, SBSBs of surfing the internet and playing computer/video games were consistently estimated to be detrimental SBs when it comes to the outcomes. Contrary to our hypothesis, the other NSBSB of talking on the phone was tied with having the most common negative associations with the study outcomes when swapping it with any of the other SBs. Furthermore, watching and streaming TV shows or movies was never the most adverse SB when it comes to mental fitness, academic achievement, pro-social behaviour, or bullying.

This study contributed to significant gaps in the research addressing the need to use time-based behaviour replacement when estimating the effects of different sedentary behaviours, whether they be screen-based or non-screen-based, and how they affect behavioural and mental health outcomes of children and youth in a Canadian sample.

### Mental Fitness

Mental fitness was estimated to be higher when reading replaced any of the other SB for all participants and boys separately. Medford and McGeown (2016) state that children with reading difficulties have shown more emotional symptoms such as anxiety and depression. Low emotional well-being and academic self-esteem may stem from children's awareness of their reading difficulties or if they have struggled with their

reading publicly (Medford & McGeown, 2016). This could suggest that those children who read more would most likely have less reading difficulties and therefore would exhibit fewer mental fitness issues such as anxiety and depression. However, it is unclear whether emotional problems could have a negative influence on children's reading development by causing children to put less effort or attention into instructions or learning activities, or if emotional issues could be the result of reading difficulties rather than being the cause (Medford & McGeown, 2016). Additionally, being good at reading because you read a lot could increase your sense of competence and autonomy which are two of the three basic needs of mental fitness. SDT maintains that the cause of many psychological problems and psychopathologies, which could arise or already be present with low mental fitness, is that one or more of the three basic needs are deprived or dissatisfied during development (Ryan & Deci, 2008).

Contrary to the popular and well-documented belief that watching TV is detrimental to health (e.g., Carson et al., 2016a; Demissie et al., 2014), it was shown to be the SB the most beneficial to the mental fitness of girls in our sample. Although the type of TV the participants watched was not specified, educational TV shows might enrich the cognitive development of children (Walsh et al., 2018). This appropriate cognitive development may contribute to heightened mental health and fitness. Compared to the other SBSBs such as the internet or being on a smartphone, TV watching can often be shared with other people, such as family and friends, and closeness to friends is associated with a significant increase in mental health (Shakya & Christakis, 2017). Relatedness is one of the three basic needs and involves connecting with and being cared for by others (Ryan & Deci, 2008). So, having TV time as a social experience that

includes connecting with others could contribute to the higher mental fitness seen among girls. When it comes to the most detrimental SB related to mental fitness, surfing the internet was estimated as being the worst when it replaced all other SB for all participants and girls separately. Multiple studies have also found that increased SBSB, especially computer use, is associated with decreased self-esteem, lower psychological well-being, and increased depression (Carson et al., 2016b; Saunders & Vallance, 2016; Shakya & Christakis, 2017; Lubans et al., 2016). For example, Shakya and Christakis (2017) maintain that time spent on social media often reduces time spent in meaningful activities and can influence internet addiction and lower self-esteem. Similarly, Ryan and Deci (2017) state that increased SBSB is leading to less time being spent outdoors, which is damaging to mental fitness as being outdoors is beneficial to our well-being; therefore, unplugging and spending time with nature can catalyze greater mental fitness. Time spent on the internet is taking away from valuable time that can be spent doing something more meaningful such as spending time with loved ones or being outdoors. Furthermore, in a study of Dutch secondary students, greater internet and video game use was associated with increased psychological problems, greater unhappiness, and decreased physical activity (Lubans et al., 2016). The opposite effect was also seen, as reducing adolescents' SBSB impacted their well-being positively (Lubans et al., 2016).

Interestingly, Bélanger, Akre, Berchtold, and Michaud (2011) found a U-shaped relationship concerning internet use and mental health, as both very high and very low intensities of internet use were associated with poorer mental health of adolescents. This could suggest that there is an optimal amount of time that children and youth should spend on the internet for healthy mental fitness levels. The poor psychological effects of

internet use could stem from what content children and teens are being subjected to. For instance, 53% of teens have felt excluded by seeing people post to social media about events that they were not invited to; 21% of teens using social media feel worse about their own lives when comparing to others on social media; 40% of teens on social media have reported that they only post content that makes them look good to others; and 39% feel pressure to post only content that will be popular and get lots of comments or likes (Lenhart et al., 2015). These statistics show that internet and social media use impact the feelings of relatedness to your peers, influence one's self-esteem by comparing themselves to others negatively, and encourages conforming to social pressures, which in the end, can cause much damage to cognitively developing children and youth.

As for boys specifically, talking on the phone was associated with the lowest mental fitness when it replaced all the other SB. This was contradictory to our hypothesis, as talking on the phone is considered a NSBSB, which was hypothesized to be beneficial to mental fitness. If the students did indeed answer the question believing it was genuinely talking on a phone with someone, this finding could be because they are staying up late talking on the phone causing sleep deprivation or even just being idle and sedentary while spending time of their phones which in turn dramatically affects their energy and vitality (Ryan & Deci 2017). However, the most obvious reason for this outcome is that perhaps the students who participated in the questionnaire misinterpreted talking on the phone as being time spent on their mobile or smartphones. It was brought up throughout focus groups during the development of the SHAPES-PEI survey that multiple students made this misattribution. What is unique about this sample of

participants is that they were “born digital,” as the majority of them do not remember a time without access to the internet or cell phones (George & Odgers, 2015).

If this is the case, similarly to the above concerns with internet use, Costigan et al. (2013) identified that increased SBSB, such as time spent on a smartphone, was positively associated with depression, and negatively associated with perceived health and social health which includes social support and socializing. Each of these outcomes is related to low mental fitness among children and youth. Mills (2016) indicated that teens that had access to a mobile device were more likely to access the internet more frequently than teens without a mobile device. If the participants were associating talking on the phone with mobile phones, this internet access could be a source of the negative association of phones and mental fitness.

On the other hand, online communication, which nowadays is often carried out by texting or messaging on smartphones, was seen to be most often used to contact existing friends and an increase in online chats with these friends was associated with higher quality friendships and well-being. Additionally, those who reported more chatting online with their friends also spent more time with those friends in person as well (George & Odgers, 2015). This shows that not all time spent on phones negatively affects mental fitness and in-person relationships. Correspondingly, strong relationships formed early in life, as in prior to 12 years old, create a higher likeliness to communicate online in adolescence, and these adolescents report having closer and more cohesive friendships (George & Odgers, 2015). This demonstrates the effect of the basic psychological need for relatedness in maintaining high mental fitness. However, it could be that many of the

study participants did not have strong relationships in childhood or were still building them.

## Academic Achievement

Similarly to mental fitness, reading was also estimated as being the SB most related to higher academic achievement when it replaced the other SBs. This finding was also stated by Carson et al. (2016b) and Lee and Carson (2017), as more time spent reading and doing homework were associated with greater academic achievement and cognitive development. This may seem intuitive, as completing homework and doing some extra reading is surely to translate into classroom success among school-aged children. Reading is essential to prepare children for school and academic achievement from the start. Shared book reading, usually done by parents reading to their children before they can read on their own, is highly associated with children's literacy development such as phonics, orthographic processes, vocabulary, reading comprehension, and literacy performance at school (Barnes & Puccioni, 2017). It was also demonstrated that not only literacy skills are formed through the quantity and quality of parent-child reading interactions in the home learning environment, but numeracy skills as well (Anders et al., 2012). This is consistent with our findings, as reading was found to be the most beneficial SB for both English and Math. It was further found that quantity and quality of being read to as a child have different outcomes: the quality of the discussion while reading was more related to mathematics, and the quantity of shared reading was greater associated with reading achievement of the child (Barnes & Puccioni, 2017). Literacy and numeracy skills often go hand-in-hand; therefore, learning to read not only improves and prepares a child for English courses but also mathematics.

Surfing the internet was estimated as the most detrimental to academic achievement in Math across the board as well as in English for girls separately. Playing video games and talking on the phone were also estimated as being negative SBs when they replaced others for English academic achievement of all participants and boys separately. When it comes to talking on the phone, there is scant research investigating its association to academic achievement, but Tang and Patrick (2018) found that talking on the phone was not significantly related to spending time doing homework, but was associated with lower odds of achieving high grades. This fits our results, but it is likely that the assumption regarding the students misinterpreting talking on the phone for time spent on smartphones still applies here, so each of these unfavourable SBs are screen-based activities. Saunders and Vallance (2016) concur with this finding as they stated that greater time spent in front of screens was negatively associated with academic achievement. Additionally, Carson et al. (2016b) found that increased time spent watching TV was significantly related to lower academic achievement. This is relevant as TV is a form of SBSB; however, our findings did not attribute TV as one of the most detrimental SBSBs. According to Wilmer et al. (2017), poor academic performance based on GPA is associated with increased levels of smartphone use, instant messaging, social networking, media multitasking, and general electronic media use, of which can all be related to internet, video games, and phone use. Oppositely, when children and youth met the screen time recommendations or even better, achieving more than one of the lifestyle behaviour recommendations, such as screen time and sleep, they had notable associations with meeting expectations for mathematics and writing (Faught et al., 2017).

When using the internet to appropriately search for resources that facilitate school work or other general information, it has been shown to be positively associated with academic achievement and activities performed on the computer may have spillover effects that can increase students' reading and problem solving skills (Chen & Fu, 2009; Tang & Patrick, 2018). However, Chen & Fu (2009) have also stated that academic achievement was negatively associated with social media and playing games. Therefore, although we have access to a limitless database of knowledge and information through the internet on our computers or smartphones, it may not be as beneficial as we would think.

Despite studies claiming to aid in cognition, many studies have found that technology, and the internet, in particular, is hindering how we remember all aspects of our lives (Wilmer et al., 2017). Regular engagement on these devices can have a negative and lasting effect on cognitions such as thinking, memory, attention, impulse control, academic performance, and emotional regulation (Wilmer et al., 2017, Walsh et al., 2018). These effects could be the result of prolonged exposure to screen-based devices since young childhood, which has become commonplace in today's generation. For example, Madigan, Browne, Racine, Mori, and Tough (2019) found that children aged 24 and 36 months who engaged in higher levels of SBSB exhibited poorer performances on a screening measure assessing children's achievement of developmental milestones, including communication and problem-solving skills, at 36 and 60 months. Lacking these skills at these young ages could translate to essential losses of skills needed for successful academic achievement in their school-aged years. On the contrary, global cognition, which includes language abilities, episodic memory, attention, processing speed, among

others, was found to be greater with each additional Canadian 24-Hour Movement Guidelines for Children and Youth that was met. This shows that the whole day matters to the cognition of children; and that the shift of lifestyle behaviours of children towards low physical activity levels, decreased sleep times, and elevated ST use could jeopardize their cognitive development (Walsh et al., 2018).

Academic achievement could be compromised because screen-based devices are distracting and require attention to be divided among various stimuli. Multi-tasking is a common occurrence among adolescents. Many students admit to frequently using multiple types of technologies at the same time, such as talking to a friend on their smartphone while also doing homework online. This multi-tasking increases error rates and adds to the amount of time typically needed to complete a task (George & Odgers, 2015). This could quickly turn into not having enough time in the day to complete homework or other assignments related to academic success and therefore result in poor academic achievement. Additionally, the most visible impact of smartphones and other mobile devices is that they have an incredible capacity to interrupt or disrupt ongoing mental or physical tasks. Whether the user's own thoughts bring them to think about a phone-related task or activity, if the device puts out an alert, or someone else is interacting with their phone, there are endless triggers to feel compelled to use a smartphone (Wilmer et al., 2017). For example, in a study by Wilmer et al. (2017), hearing or feeling a vibration associated with a phone alert, or simply even knowing that there is a cell phone present in the room, was enough to distract the participant from focusing their attention on the primary task and result in poorer performance. When attention is divided due to the presence of communication technologies, it negatively

affects individuals' working memory, increases distractedness, and complicates distinguishing between what information is relevant or not (Misra, Cheng, Genevie, & Yuan, 2014). If these distractions are present throughout the whole life of a child, you could see how they may never develop an attention span that can last long enough to sit down and focus on schoolwork.

As with any technological advancement, we adapt to its use and come to rely on it. Modern technology is available to store much of our information for us, so we depend on our devices and become less likely to encode and store the information in our long-term memory (Wilmer et al., 2017). The term digital amnesia was given to the phenomenon of forgetting information due to the fact that your digital device will store and remember it for you (Agbo-Egwu, Abah, & Anyagh, 2018). This is being demonstrated in many ways, such as writing important information in smartphone notes or taking a photo of an experience instead of watching it with your own eyes. Although digital technologies have made our lives simpler in many ways, the over-dependence on them is detrimental to children's memory and has been explicitly studied as being related to mathematical memory (Agbo-Egwu et al., 2018). With the never-ending availability of search engines online, students are abandoning the process of simple recall of important foundational mathematical concepts that previously would have been memorized, because the technologies can do it for them. This trend is threatening the preservation and transfer of mathematical culture (Agbo-Egwu et al., 2018). This concept of digital amnesia could help explain what our results demonstrated, specifically for the internet being the worst SB when it replaced all others for academic achievement in math in all participants.

Video games were found to have the most detrimental effects for all participants in relation to academic achievement in English courses, most likely for the reasons above, such as multi-tasking, cognitive developmental issues, and not meeting ST guidelines. However, there is also evidence of beneficial effects of video games on cognitive processes. Walsh et al. (2018) stated that some video games, depending on content, could benefit information processing and visuospatial abilities of children. Furthermore, many studies have demonstrated the positive effects that some video games have on skills such as selective attention, sustained attention, task-switching, and visual short-term memory (Wilmer et al., 2017). Because of these conflicting beneficial findings, it is unclear whether or not these skills prevail in academic achievement or whether the above negative mechanisms are at play for students in our study.

### Pro-Social Behaviour

Pro-social behaviour was estimated as being the highest when reading substituted any other SB. This finding was consistent with mental fitness and academic achievement. Regarding pro-social behaviours, it could be that those children and adolescents who do not read very often have low pro-social behaviour. For example, Medford and McGeown (2016) highlight that children who exhibit reading difficulties often engage in more anti-social, aggressive, defiant, and rule-breaking behaviour, even after controlling for intelligence. These types of behaviours would be classified as the opposite of pro-social. Correspondingly, Halonen, Aunola, Ahonen, and Nurmi (2006) found that when children struggle to learn to read in the first two years of school, it is more likely to produce anti-social behaviour and problematic relations with peers. These findings demonstrate that difficulty in reading could cause some stress among children and cause them to act out in

other ways. It is possible, however, that the relationship between reading development and conduct problems is bi-directional (Medford & McGeown, 2016). This suggests that those children who were going to act in anti-social ways were going to have lower reading abilities from the start. Based on our findings, even if a child struggles to read, it is beneficial to keep reading and to improve their skills to promote more pro-social behaviours.

On the other side of pro-social behaviour, computer and video games have been estimated as being the worst SB when replacing all other SBs. As video games are also a form of screen-based sedentary behaviours, increased time spent in front of screens and playing video games was related to lower pro-social behaviour and poor behavioural conduct (Saunders & Vallance, 2016; Carson et al., 2016b). This outcome was also supported by Leeuw, Bruijn, Oene, and Schrijvers (2010) as they discovered that frequent video or computer game players displayed more behavioural problems and were less happy at school. As mentioned before, meeting the movement behaviour recommendations of two hours of screen time is an essential determinant in a child's psychosocial health (Walsh et al., 2018).

Statistically, pro-social behaviour is the opposite of aggressive behaviour (Boxer et al., 2004). This could explain that if the students are immersing themselves in violent, aggressive video games, this behaviour could translate to their lives. There is abundant research on the connections between violent video games and the translation of aggressive behaviour among its players. For instance, Anderson et al. (2010) state that exposure to violent video games is a risk factor for aggressive behaviour, cognition, and affect, and negatively associated with empathy and pro-social behaviour. The Social

Learning Theory by Bandura (e.g., 1973) posits that children learn behaviour, aggressive or not, the same way- through direct experience and by observing and imitating others. Therefore, whichever type of video game they play, whether it is violent or not, will have at least a small effect on how they behave. They most likely will not imitate the specific behaviours, like killing someone in a war game, but they may alter their behaviour to become more aggressive such as calling names or pushing their peers (Zhaojun et al., 2019). Being exposed to violent video games increases moral disengagement- which is the process of justifying unacceptable behaviours towards others, and dehumanization in teens, which provokes the mindset that can lead to the belief that aggression is appropriate and translates to real-world behaviour (Hartmann, Krakowiak, & Tsay-Vogel, 2014; Zhaojun et al., 2019). Some of the common reasons violence in video games is justified is that most of the opponents are gruesome, they are playing for a higher good, there are rewards for violence, and the suffering of the characters is not displayed (Hartmann et al., 2014). These cognitions are what keep the children and adolescents playing these games but are subconsciously affecting their behaviours outside of playing the game, such as a lack of altruistic pro-social behaviour. Understandably, computer and video games are not exclusively aggressive. There are also more positive games that are known in the literature to be a part of pro-social media. Pro-social media or video games, which are defined by Greitemeyer (2011) as games that include the predominant goal benefiting or helping another game character, can decrease aggressive behaviours and increase pro-social behaviours. Pro-social media influences behaviour by priming the observer to be pro-social, increasing positive affect associated with the game, and especially promoting empathy among the viewers (Prot et al., 2014). When adolescents

played pro-social video games, it was associated with more frequent helping, cooperation, and sharing, while violent gameplay was negatively associated with pro-social behaviours and traits (Gentile et al., 2009). This information suggests that our results are pointing to the fact that the students must be playing aggressive video games that hinder pro-social behaviour, rather than augmenting their pro-social behaviour with pro-social media games; however, we do not have the data to support what type of games they played. Interestingly, Prot et al. (2014) found that no matter what kind of media, whether it is pro-social or violent, the longer time spent using it was associated with decreased pro-social behaviour, which is the result of a lack of empathy. This finding is indeed in line with our results. Mechanisms for this might include more time on media results in less time to help people, but because of empathy's role in this relationship, Prot et al. (2014) speculated that it was because more time spent with this technology leads to fewer socialization opportunities for children to learn empathy for others. Additionally, empathy has been demonstrated as a means for engaging in altruism, as increasing connections and interacting with others instills a sense of community and caring for them which leads to strong other-concern and empathy. These social connections are what will enhance children's likelihood to help others (Strangor, Jhangiani, & Tarry, 2014). We must emphasize these important social norms among our children to ensure a helping and empathetic society.

The importance of interacting with others in-person was demonstrated in an intervention study done by Uhls et al., (2014) where pre-teens spent five days at a camp without any screen-based media or digital communication and engaged in plenty of face-to-face interactions. At the end of the five days, the pre-teens improved significantly in

their ability to recognize nonverbal emotion cues than the control group. This increased social interaction paired with a break from screens demonstrated positive effects that although are not directly pro-social behaviour, the ability to process emotional cues efficiently could contribute to an adolescents' drive to participate in social and helpful behaviours (Uhls et al., 2014). By using digital technology too often, there is an obvious lack of nonverbal emotional cues, such as eye contact and pointing, that would normally be present in face-to-face interactions, which hinders young children's ability to master critical social skills (Uhls et al., 2014). This study stresses the importance of limiting computer and video games, or SBSB in general for the development of optimal altruistic pro-social behaviour.

## Bullying

Being bullied by others was found to be least likely when video or computer games replaced all other sedentary behaviours for all participants as well as for girls separately. This finding was surprising; as we hypothesized all SBSBs would result in adverse outcomes surrounding bullying variables. However, our results could be because many video games can be socially interactive, such as multiplayer electronic games or social networking games, and they are associated with producing greater social health benefits, especially connectedness, for adolescent girls rather than playing computer or video games in isolation (Costigan et al., 2013). This connectedness can produce more healthy relationships with peers which could, in turn, reduce the incidence of being bullied by others. Lenhart et al. (2015) found that boys are more likely to play video games than girls, which was correspondingly reproduced in our results, and boys were more apt to use video games as a means for conversations and feeling connected with

current friends and to build new friendships through online gaming. This is somewhat contradictory to our results, as the most beneficial SB for boys was internet; however, it could contribute as a mechanism for why all participants together benefitted from video games when it comes to being bullied by others. Furthermore, Lenhart et al. (2015) noted that while 75% of adolescents who play video games connect with other "online gamers," 89% tend to play with their friends in person. If playing video games encourages young people to spend more time socializing with their peers, then this promotes stronger peer relationships. As stated by Healy and Sanders (2018), support and acceptance from peers defend children from ongoing bullying and internalizing their problems by protecting their emotional health. Furthermore, peers are more likely to help and stand up for the victim when they have a positive relationship with them, so promoting victims of bullying to form strong peer relationships is essential in combatting bullying (Healy & Sanders, 2018).

On the other hand, the most beneficial SB when replacing all others for boys separately was found to be surfing the internet. Similar to the proposed mechanism of video and computer games, internet and social media can act as a way for teens to feel more connected to their friends' feeling and daily lives, as well as being a means for friends to provide support during challenging times (Lenhart et al., 2015). Additionally, Mills (2016) states that social networking, can act to increase feelings of peer affiliation and adolescents who use these sites report being less lonely. This could be because adolescents engaging in online conversations after experiencing social rejection or isolation might benefit their mental state and help them "bounce back" by building networks and confidence (George & Odgers, 2015). Although it may seem like children

and youth are contacting strangers and "online friends" teens that can access the internet through a mobile device are much more likely to be contacting their closest friend than those without this kind of access (Lenhart et al., 2015). This additional communication via internet might influence teens to spend more time face-to-face, as Lenhart et al. (2015) found that more teens reported spending time with their friends at school (83%) or someone's house (58%) than online (55%). This could be a result of using the internet to communicate and make plans to meet up face-to-face, which in turn, helps build healthy relationships among peers to resist bullying. Even though these findings seem to point to the benefits of interacting with others on the internet, the social benefits related to internet communication may depend on individual baseline social cognitive skills. Those who are lower in specific skills may not gain these advantages due to their lack of already formed peer relationships, and those who have higher social cognitive skills and pre-formed friendships may benefit from the increased communication online (Mills, 2016).

When looking at the most beneficial SB when replacing all others for the least likelihood of bullying others, reading came out on top. This could intuitively be explained by merely a difference in time allocation, being that if you are spending time reading, you cannot be bullying someone, which is not the case for the other SBs such as the internet, video games, and engaging with social media on smartphones, as the capacity to cyber bully a peer is present. Moreover, the opposite behaviour, being a lack of reading, could help explain why reading is so beneficial regarding not bullying others. Independent of general intelligence and decoding ability, reading volume contributed significantly to reading ability, specifically vocabulary knowledge, spelling, and verbal fluency (Cunningham & Stanovich, 2001). This becomes a rich-get-richer, poor-get-

poorer situation for children and reading capability. The more they read, the greater reading ability, and the less they read the more difficulties they will experience. This occurs because early on when learning to read, poor readers who encounter more issues with breaking the spelling-to-sound code start to be less and less exposed to reading compared to their more skilled peers. This transpires due to damaging reading experiences arising from being immersed in reading materials too advanced for them, along with lack of decoding skills and lack of practice. This deters children from continuing to engage in reading-related activities (Cunningham & Stanovich, 2001). To connect these effects to bullying others, Halonen et al. (2006) found that in the first two years of school, when children experience problems in learning to read, it predicted an increase in anti-social behaviour and problematic interactions with peers. Additionally, conduct problems, such as anti-social, aggressive, defiant, and rule-breaking behaviour are positively associated with children with reading difficulties more than typical readers and negatively related to children's reading ability, despite controlling for intelligence (Medford & McGeown, 2016). Despite this evidence suggesting that the more children and youth read, especially early on, the less difficulties they will have and the better habits surrounding reading will be formed, which in turn relates to less behavioural conduct issues and bullying peers out of externalizing this frustration, the relationship between conduct problems and reading proficiency could be bi-directional (Medford & McGeown, 2016). This means that perhaps children who exhibit behavioural conduct problems may be less likely to be proficient at reading or to read very often, as opposed to reading difficulties leading to less desirable behaviour.

When looking at both sides of a bullying encounter- the bully and the victim, talking on the phone was associated with being the least desirable SB when replacing all others for bullying others and being bullied by others, except for girls separately when bullying others. Similar to the above outcomes, the assumption that many students misinterpreted talking on the phone as being time spent talking to others via a smartphone still stands. On a comparable note, Lenhart (2012) documented that teens are increasingly using the texting functions of cellphones and are less likely to use them for calling. Likewise, they found that teens are using landlines to talk to their friends less often or not at all (Lenhart, 2012), and Leatherdale (2010) found a correlation between high levels of communication time among students and high levels of screen time.

So due to this, it is logical to assume that access to a cellphone, specifically a smartphone, would result in time spent on the internet and social media. Mills (2016) found that adolescents who have access to a mobile device spend more time on the internet than those without one. The increase in growth and popularity of texting and social networking has made it possible to be connected to others at all hours of the day with a lack of parental monitoring. This becomes a perfect opportunity for students to engage in or be the victim of cyber-bullying such as spreading rumors about and socially sabotaging or black-mailing peers which result in fear, helplessness, and humiliation (Pelfrey & Weber, 2014; George & Odgers, 2015). Our supplemental results about specific types of bullying replicate this particularly significantly (see Appendix, table 9), as when all students swapped reading for talking on the phone, they were 61% more likely to have bullied others by cyber-attack and outstandingly in the same behaviour swap, girls separately were 90% more likely to have bullied others by cyber-attack.

Lenhart et al. (2015) demonstrate this type of bullying by noting that 42% of teens using social media have had someone post something on social media about them that they could not change or control. These events happen more than one would believe and they fall under acts of cyber-bullying. On the other hand, when all participants replaced reading for talking on the phone, they were 25% more likely to have been bullied by others by cyber-attack. This shows that the relationship goes both ways with spending time on a phone; however it is stronger when it comes to being the bully rather than the victim.

Cyber-bullying has become more and more prominent due to the nature of technology advancements, as well as the fact that the long-term repercussions that come with traditional bullying methods do not seem as threatening and immediate in cyber-bullying (Pelfrey & Weber, 2014). Students can passively hide behind their screens and can even act anonymously when engaging in bullying behaviours online. This results in increased harshness and distribution of comments or posts on online engagements that would often never be said or acted on in person as well as the fact that once they are posted online, they are often there permanently for anyone to find, even after deleting them (George & Odgers, 2015). Furthermore, these issues that originate online can spill over to school or face-to-face confrontations that could then lead to other, more visible forms of bullying including physical confrontations (Pelfrey & Weber, 2014). This phenomenon is happening much more than are reported, and even small jokes or teasing could be taken negatively and severely affect students' well-being, and even goes so far as the significantly increasing, highly publicized consequence of teen suicide (Pelfrey & Weber, 2014). Being on a smartphone both exposes children and youth to being bullied

online as well as gives students a less visible and less threatening, yet equally or even more damaging, method and opportunity to intimidate others that is becoming increasingly significant among the younger generations today.

By the same token as talking on the phone and its connection to spending more time on the internet, surfing the internet was found as being the worst SB for girls specifically, when replacing all others for bullying others. Most notably, our results from the specific forms of bullying (see Appendix, table 9) found that when girls replaced reading with the internet, they were estimated to be 116% more likely to have bullied others by cyber-attack. Corresponding to our results of girls surfing the web 1.50 hours per day and boys only 1.14 hours per day, Leeuw et al. (2010), found that girls spend more time on the internet than boys; therefore, this could be a reason as to why the internet is the most negative SB when swapping it for all others for girls bullying others. Additionally, Leeuw et al. (2010) stated that greater time spent on the internet is associated with more behavioural problems and being less happy at home and school. This could result in bullying because of acting out and taking out personal frustrations on peers. Conversely, Lenhart et al. (2015) propose some positive evidence about girls spending time on the internet, as they are more likely to use social media to meet new friends than boys, which could result in less bullying due to peer support found in friendships, similar to the peer support mechanism mentioned in relation to video games.

## Sleep

Again and again, sleep came up in the literature as a potential mechanism for why the screen-based SBs continually showed adverse behavioural and mental health outcomes, especially for mental fitness, academic achievement, and bullying outcomes.

The Canadian 24-Hour Movement Guidelines for Children and Youth recommend 9-11 hours per night of sleep, so not getting this amount has been shown to affect health negatively. Because it was a repetitive theme, the following paragraphs will address how sleep is related to its specific outcomes.

As for mental fitness, surfing the internet and talking on the phone or using a smartphone were the primary culprits in decreasing mental fitness when swapping other SBs for them. Teens that own a smartphone, rather than a conventional mobile phone, are associated with engaging in more electronic media, including calling, texting, and spending time online in bed before sleep and this use is related to later bedtimes. Greater electronic media use was associated with decreased sleep duration and more sleep difficulties, which together can lead to depressive symptoms (Lemola, Perkinson-Gloor, Brand, Dewald-Kaufmann, & Grob, 2015). Sampasa-Kanyinga, Hamilton, and Chaput (2018) also noted that sleep duration had a significant effect on self-rated mental health. They found this effect to most-likely be due to the direct displacement of sleep duration by social media through late-night use could shift the circadian rhythm and increase mental and physiological arousal before bedtime, which would delay sleep onset. Additionally, social media could cause melatonin suppression due to the blue light coming from screen devices (Sampasa-Kanyinga et al., 2018). Aside from the mechanisms due to the screens, adolescence is a time when poor mental health, including depression, becomes increasingly prevalent. Sleep disturbance is a considerable risk factor for the development of depression at this time and excessive technology and screen use at night is a risk factor related to both sleep disturbance and depression (Lemola et al., 2015). According to Liu et al. (2007), 73% of adolescents who have a depressive

disorder also suffer from a sleep disorder, making this comorbidity very prominent. Sleep disturbance has been shown to act as a precursor to the development of depression with minimal studies finding support for the opposite. This highlights the importance of adolescents getting a good sleep, which comes with less time spent on electronic media before bed (Lemola et al., 2015). Although mental fitness is not just depression, it does encompass psychological well-being, which is not achieved when one is suffering from mental health issues such as depression.

Academic achievement has been found to be less advanced when spending more time on the internet, playing video games, and on the phone. Like mental fitness, reasons for insufficient sleep among adolescents include artificial light, caffeine intake, lack of bedtime rules in the household, and the increased use of communication technology (Sampasa-Kanyinga et al., 2018). So the three behaviours above could all contribute to insufficient sleep, which along with concurrent daytime sleepiness, are related to poor academic achievement among adolescents (Sampasa-Kanyinga et al., 2018). In a study by Faught et al. (2017), sleep was associated with performance on writing exams as it has exhibited its importance for writing skills including creativity and insight. When a student does not have the mental capability to make it through an exam due to lack of sleep, it is hard to achieve the outcome they would like. This connection of appropriate and sufficient sleep time and academic achievement goes so far back as to play an essential part in brain development and plasticity. It breeds greater cognition and academic performance in school-aged children. For example, longer sleep duration was related to enhanced verbal skills and IQ measures in children aged 6-13 as opposed to shorter sleep times (Walsh et al., 2018). Finally, many of the negative cognitive and

affective outcomes coming from smartphone and other digital media use may stem indirectly from its influences on sleep and mood (Wilmer et al., 2017). From this evidence, it is clear to see that digital technologies could be affecting sleep time and subsequently, academic achievement in school-aged children and youth.

Surfing the internet and talking on the phone are the least favourable SBs when replacing all others for both bullying outcomes. This screen-time trend continues for a mechanism contributing to lack of sleep, due to previously mentioned effects such as shifts in circadian rhythm, increased arousal, and melatonin suppression due to the blue light of screen devices (Sampasa-Kanyinga et al., 2018). The use of social media by students aged 11-20 years was related to shorter sleep duration (Sampasa-Kanyinga et al., 2018). Besides these mechanisms, the changes that occur in puberty also include a modification in the brain that makes it naturally wired to stay up later and sleep in longer than children, but on weekdays, they often stay up late but are not able to make up for lost sleep time by sleeping in, which results in insufficient sleep (George & Odgers, 2015). Regardless of why children and youth are not getting enough sleep, when studying bullies, the ones who had insufficient sleep duration at baseline demonstrated significantly higher levels of aggression than those who got enough sleep (Na & Park, 2018).

Moreover, insufficient sleep, chronically disrupted sleep patterns, and shorter sleep duration were more likely to be positively related to adolescents displaying emotional and behavioural issues and aggressive behaviours including school violence than having healthy sleeping patterns (Na & Park, 2018). Similarly, Hildenbrand, Daly, Nicholls, Brooks-Holliday, and Kloss (2013) found that students who engaged in the majority of

school-related violence were more likely to have insufficient sleep. An explanation for this is that sleep disturbance results in physiological arousal and sleeplessness that result in poor prefrontal cortical function, which contributes to aggressive behaviours such as bullying (Na & Park, 2018). Additionally, when children and youth don't get adequate sleep, their behavioural and emotional regulation is decreased which results in less of a tolerance for frustration, and greater irritability, aggression, hostility, and conduct issues (Hildenbrand et al., 2013). On the other side of bullying, lack of sleep can also be found to have associations with being bullied. According to Hildenbrand et al. (2013), teens that had insufficient sleep were more likely to be bullied and/or threatened or injured with a weapon on school property. Comparably, many children who report sleeping poorly also report being the victims of bullying more than their peers (Williams, Chambers, Logan, & Robinson, 1996). Although these findings align, no mechanisms describing this relationship were proposed. Perhaps those who are staying up late on their devices are so tired in school that they do not have the energy to defend themselves or present themselves as easy targets to bullies.

## Limitations

Limitations of this study are first of all that it is a secondary analysis of cross-sectional data. Therefore, we cannot draw causal conclusions, and all of our results are just estimations of the effects each SB has on all of the outcomes. Secondly, all of the data are self-reported measures from children and youth in grades 5-12. Student responses could be inaccurate as they may have answered incorrectly on purpose for questions addressing personal topics such as mental fitness or bullying outcomes, or answers could be off due to students' comprehension of questions asked, as well as

mistakes with memory recall (Murnaghan et al., 2014). Thirdly, our data was able to give us a representative sample of PEI students; however, there was a significant amount of students in this age-group on PEI that were not included in the study. Whether these encompassed students from schools that did not fit the inclusion criteria (see Participants and Study Design) or grades in 6-12 of which randomly selected two-thirds of the participants to complete the SHAPES-PEI survey, while the remaining third completed the CSTADS questionnaire. This leaves the study sample as potentially missing some critical information from these populations that were excluded and possibly skewing the results. Furthermore, the "Total Sedentary Time" variable only includes the five measured SBs; so inevitably, there would be sedentary time throughout a students' day that would not be accounted for here. Additionally, it was thought that sleep could be a significant mechanism that could affect these outcomes due to time spent on screen-based devices displacing sleep as well as the nature of teenagers not wanting to go to sleep as early as when they were younger; however, sleep was not directly measured in the SHAPES-PEI survey. Finally, on a similar note, mental health disorders such as depression and anxiety are huge concerns, especially among children and youth. For example, Teychenne, Abbott, Lamb, Rosenbaum, and Ball (2017) stated that depression is trending to be the second leading cause of disease burden worldwide by 2020 and that currently, it is estimated that globally, 298 million people, with about two-thirds being women, experience major depressive disorder. However, they too were not directly measured throughout the survey, which impedes our ability to make direct connections to mental health outcomes and how they relate to our results.

## Future Directions

For future research in this area, it would be beneficial to investigate longitudinal data or implement intervention studied on school-aged children, as it would provide a clearer picture of the trends that were observed throughout this study and permit the establishment of any causal relationships. Secondly, the contextualization of each SB would be favourable. For example, when asking about time spent reading, to ask what type of material they are reading and on what medium (paper or screen) they are reading. When asking about TV or video games, determining what kind of shows they are watching or what games they are playing. This method could be continued throughout the questionnaire, as many of the possible explanations for the results of this study depend on what exactly is going on while being sedentary. Tang and Patrick (2018) also suggest that future studies in this area consider the content of adolescents' conversations and interactions on social media platforms to examine unique relationships with behavioural outcomes. It could also be valuable to take into consideration the time spent multitasking on multiple SBSBs. This could significantly affect how each of these screen-based activities is influencing behavioural and mental health outcomes.

## CONCLUSION

In summary, this study allowed for greater insight into the differences among SBs and estimated that not all SBs are the same when assessing their effects on behavioural and mental health outcomes such as mental fitness, academic achievement, pro-social behaviour, and bullying. After conducting ISM on the estimated impacts of each SB on the study outcomes, it was found that reading was the most beneficial behaviour when replacing all other SBs for five out of the six dependent variables. Internet was shown to be the least favourable SB, as it was estimated as being the worst in two out of six and the second worst in three out of six outcomes when it replaced all other behaviours. TV viewing was not found to be as harmful as previous studies have suggested. It was never the worst and never the best when it replaced other SBs, as it could be the most social out of all of the SBSBs, promoting connectedness among viewers. And conversely to our original hypothesis, talking on the phone was not as beneficial as imagined, as it was most likely an issue of participants misinterpreting its meaning as being time spent on smartphones; therefore, it was regarded as a SBSB rather than a NSBSB.

It is known that meeting multiple or all 24-hour movement behaviour guidelines is the optimal target for children and youth`s health and development; however, we seem to be at an all-time low for correctly following these recommendations. Participation in physical activity, modeling of healthy lifestyles, and limiting children`s access to media by parents and other influential adults such as teachers and coaches may be crucial in reducing sedentary behaviours among children (Springer, Kelder, & Hoelscher, 2006). However, we are not at a point, nor will we ever be, where excess SB does not exist. Therefore, in the absence of sufficient physical activity, which has been shown to benefit

each of the study outcomes optimally, it was estimated that reading might be the most beneficial of all sedentary behaviours on behavioural and mental health outcomes.

## REFERENCES


Agbo-Egwu, A. O., Abah, J. A., & Anyagh, P. I. (2018). The influence of smart phone over-dependence on the recall of basic mathematics among mathematics education students in a Nigerian university. Science & Technology, 4, 97-105.

Anderson, C. A., Shibuya, A., Ihori, N., Swing, E. L., Bushman, B. J., Sakamoto, A... Saleem, M. (2010). Violent video game effects on aggression, empathy, and prosocial behavior in eastern and western countries: A meta-analytic review. *Psychological Bulletin*, 136, 151–173

Bandura, A. (1973). Aggression: A social learning theory analysis. Englewood Cliffs, NJ: Prentice Hall.

Barnes, E., & Puccioni, J. (2017). Shared book reading and preschool children's academic achievement: Evidence from the Early Childhood Longitudinal Study-Birth cohort. Infant & Child Development, 26(6), n/a-N.PAG.

Bélanger, R. E., Akre, C., Berchtold, A., & Michaud, P. A. (2011). A U-Shaped Association Between Intensity of Internet Use and Adolescent Health. Pediatrics,127(2), E330-E335. doi:10.1542/peds.2010-1235d

Bezold, C. P., Konty, K. J., Day, S. E., Berger, M., Harr, L., Larkin, M., . . . Stark, J. H. (2014). The Effects of Changes in Physical Fitness on Academic Performance Among New York City Youth. *Journal of Adolescent Health,55*(6), 774-781. doi:10.1016/j.jadohealth.2014.06.006

Boxer, P., Tisak, M. S., Goldstein, S. E. (2004). Is it Bad to be Good? An Exploration of Aggressive and Prosocial Behaviour Subtypes in Adolescence. *Journal of Youth and Adolescence, 33*(2), 91-100.

Boyd, D., & Hargittai, E. (2013). Connected and concerned: Variation in parents online safety concerns. Policy & Internet,5(3), 245-269. doi:10.1002/1944-2866.poi332

Cabanas-Sánchez, V., Martínez-Gómez, D., Esteban-Cornejo, I., Pérez-Bey, A., Piñero, J. C., & Veiga, O. L. (2018). Associations of total sedentary time, screen time and non-screen sedentary time with adiposity and physical fitness in youth: The mediating effect of physical activity. Journal of Sports Sciences,37(8), 839-849. doi:10.1080/02640414.2018.1530058

Carson, V., Hunter, S., Kuzik, N., Gray, C. E., Poitras, V. J., Chaput, J., . . . Tremblay, M. S. (2016a). Systematic review of sedentary behaviour and health indicators in school-aged children and youth: An update. *Applied Physiology, Nutrition, and Metabolism,41*(6 (Suppl. 3)). doi:10.1139/apnm-2015-0630

Carson, V., Tremblay, M. S., Chaput, J., & Chastin, S. F. (2016b). Associations between sleep duration, sedentary time, physical activity, and health indicators among Canadian children and youth using compositional analyses. *Applied Physiology, Nutrition, and Metabolism,41*(6 (Suppl. 3)). doi:10.1139/apnm-2016-0026

Chen S, & Fu Y. (2009). Internet use and academic achievement: gender differences in early adolescence. *Adolescence*, 44(176), 797–812.

Costigan, S. A., Barnett, L., Plotnikoff, R. C., & Lubans, D. R. (2013). The Health Indicators Associated With Screen-Based Sedentary Behavior Among Adolescent Girls: A Systematic Review. *Journal of Adolescent Health*,52(4), 382-392. doi:10.1016/j.jadohealth.2012.07.018

Cunningham, A. E., & Stanovich, K. E. (2001). What Reading Does for the Mind. *Journal of Direct Instruction*, 1(2), 137-149.

Cusack, S. A., & Thompson, W. J. (1998). Mental fitness: Developing a vital aging society:Mens sana in corpore sano. *International Journal of Lifelong Education,17*(5), 307-317. doi:10.1080/0260137980170503

Demissie, Z., Lowry, R., Eaton, D. K., Hertz, M. F., & Lee, S. M. (2014). Associations of School Violence with Physical Activity among U.S. High School Students. *Journal of Physical Activity and Health,11*(4), 705-711. doi:10.1123/jpah.2012-0191

Ekblom-Bak, E., Ekblom, Ö, Bergström, G., & Börjesson, M. (2015). Isotemporal substitution of sedentary time by physical activity of different intensities and bout lengths, and its associations with metabolic risk. *European Journal of Preventive Cardiology,23*(9), 967-974. doi:10.1177/2047487315619734

Faught, E. L., Ekwaru, J. P., Gleddie, D., Storey, K. E., Asbridge, M., & Veugelers, P. J. (2017). The combined impact of diet, physical activity, sleep and screen time on academic achievement: A prospective study of elementary school students in Nova Scotia, Canada. *The International Journal of Behavioral Nutrition and Physical Activity*, 14.

Gentile, D. A., Anderson, C. A., Yukawa, S., Ihori, N., Saleem, M., Ming, L. K., . . . Sakamoto, A. (2009). The Effects of Prosocial Video Games on Prosocial Behaviors: International Evidence From Correlational, Longitudinal, and Experimental Studies. *Personality and Social Psychology Bulletin*,35(6), 752-763. doi:10.1177/0146167209333045

George, M. J., & Odgers, C. L. (2015). Seven Fears and the Science of How Mobile Technologies May Be Influencing Adolescents in the Digital Age. *Perspectives on Psychological Science*,10(6), 832-851. doi:10.1177/1745691615596788

Greitemeyer, T. (2011). Effects of Prosocial Media on Social Behavior: When and Why Does Media Exposure Affect Helping and Aggression? Current Directions in Psychological Science, 20(4), 251–255.

Grgic, J., Dumuid, D., Bengoechea, E. G., Shrestha, N., Bauman, A., Olds, T., & Pedisic, Z. (2018). Health outcomes associated with reallocations of time between sleep, sedentary behaviour, and physical activity: A systematic scoping review of isotemporal substitution studies. *International Journal of Behavioral Nutrition and Physical Activity*, *15*(1). doi:10.1186/s12966-018-0691-3

Guo, Q., Wu, R., & Li, X. (2017). Beneficial effects of pro-social behaviour on physical well-being in Chinese samples. *Asian Journal of Social Psychology*,*21*(1-2), 22-31. doi:10.1111/ajsp.12193

Hale, L., & Guan, S. (2015). Screen time and sleep among school-aged children and adolescents: A systematic literature review. *Sleep Medicine Reviews*,*21*, 50-58. doi:10.1016/j.smrv.2014.07.007

Halonen, A., Aunola, K., Ahonen, T., & Nurmi, J.-E. (2006). The role of learning to read in the development of problem behaviour: A cross-lagged longitudinal study. *BRITISH JOURNAL OF EDUCATIONAL PSYCHOLOGY*, (3), 517.

Hartmann, T.K., Krakowiak, M., & Tsay-Vogel, M. (2014) How Violent Video Games Communicate Violence: A Literature Review and Content Analysis of Moral Disengagement Factors, Communication Monographs, 81:3, 310-332, DOI: 10.1080/03637751.2014.922206

Healy, K. L., & Sanders, M. R. (2018). Mechanisms Through Which Supportive Relationships with Parents and Peers Mitigate Victimization, Depression and

Internalizing Problems in Children Bullied by Peers. *Child Psychiatry & Human Development,*49(5), 800-813. doi:10.1007/s10578-018-0793-9

Hertz, M. F., Jones, S. E., Barrios, L., David-Ferdon, C., & Holt, M. (2015). Association Between Bullying Victimization and Health Risk Behaviors Among High School Students in the United States. *Journal of School Health,85*(12), 833-842. doi:10.1111/josh.12339

Hildenbrand, A. K., Daly, B. P., Nicholls, E., Brooks-Holliday, S., & Kloss, J. D. (2013). Increased Risk for School Violence-Related Behaviors Among Adolescents With Insufficient Sleep. *Journal of School Health,83*(6), 408-414. doi:10.1111/josh.12044

Hunter, S., Leatherdale, S. T., & Carson, V. (2018). The 3-Year Longitudinal Impact of Sedentary Behavior on the Academic Achievement of Secondary School Students. *Journal of School Health,*88(9), 660-668. doi:10.1111/josh.12672

Koestner, R.F, & Véronneau, M.H. (2001). *Children`s Intrinsic Needs Satisfaction Sacle.* Un-published questionnaire, McGill University, Montreal, Quebec, Canada.

Leatherdale, S. T. (2010). Factors Associated With Communication-Based Sedentary Behaviors Among Youth: Are Talking on the Phone, Texting, and Instant Messaging New Sedentary Behaviors to be Concerned About? *Journal of Adolescent Health,*47(3), 315-318. doi:10.1016/j.jadohealth.2010.02.012

Lee, E., & Carson, V. (2017). Physical activity, sedentary behaviour, and psychosocial well-being among young South Korean children. *Child: Care, Health and Development,44*(1), 108-116. doi:10.1111/cch.12491

Leeuw, J. R., Bruijn, M. D., Oene, G. H., & Schrijvers, A. J. (2010). Internet and game behaviour at a secondary school and a newly developed health promotion programme: A prospective study. *BMC Public Health,*10(1). doi:10.1186/1471-2458-10-544

Lemola, S., Perkinson-Gloor, N., Brand, S., Dewald-Kaufmann, J., & Grob, A. (2015). Adolescents' Electronic Media Use at Night, Sleep Disturbance, and Depressive Symptoms in the Smartphone Age. *Journal of Youth & Adolescence, 44*(2), 405–418.

Lenhart, A. (2012). Teens, Smartphones, & Texting. *Pew Internet & American Life Project.* http:// pewinternet.org/Reports/2012/Teens-and-smartphones.aspx.

Lenhart, A., Smith, A., Anderson, M., Duggan, M., & Perrin, A. (2015). Teens, Technology and Friendships (pp. 1-75, Rep.). *Pew Research Center*.

Liu, M., Wu, L., & Yao, S. (2015). Dose–response association of screen time-based sedentary behaviour in children and adolescents and depression: A meta-analysis of observational studies. *British Journal of Sports Medicine,50*(20), 1252-1258. doi:10.1136/bjsports-2015-095084

Lubans, D. R., Smith, J. J., Morgan, P. J., Beauchamp, M. R., Miller, A., Lonsdale, C., . . . Dally, K. (2016). Mediators of Psychological Well-being in Adolescent Boys. *Journal of Adolescent Health*,58(2), 230-236. doi:10.1016/j.jadohealth.2015.10.010

Madigan, S., Browne, D., Racine, N., Mori, C., Tough, S. (2019). Association Between Screen Time and Children's Performance on a Developmental Screening Test. *JAMA Pediatr*. doi:10.1001/jamapediatrics.2018.5056

Medford, E., & Mcgeown, S. P. (2016). Social, emotional and behavioural influences on young childrens pre-reading and word reading development. *Journal of Applied Developmental Psychology*,43, 54-61. doi:10.1016/j.appdev.2015.12.008

Mekary, R. A., Willett, W. C., Hu, F. B., & Ding, E. L. (2009). Isotemporal Substitution Paradigm for Physical Activity Epidemiology and Weight Change. *American Journal of Epidemiology*,*170*(4), 519-527. doi:10.1093/aje/kwp163

Mills, K. L. (2016). Possible Effects of Internet Use on Cognitive Development in Adolescence. *Media and Communication*,*4*(3), 4-12. doi:10.17645/mac.v4i3.516

Misra, S., Cheng, L., Genevie, J., & Yuan, M. (2014). The iPhone Effect: The Quality of In-Person Social Interactions in the Presence of Mobile Devices. *Environment and Behavior*,48(2), 275-298. doi:10.1177/0013916514539755

Murnaghan, D., Morrison, W., Laurence, C., & Bell, B. (2014). Investigating Mental Fitness and School Connectedness in Prince Edward Island and New Brunswick, Canada. *Journal of School Health*, *84*(7), 444–450.

Na, H., & Park, H. (2018). Longitudinal effects of insufficient sleep on psychological problems among adolescent bullies based on Korean Child and Youth Panel

Survey. *Archives of Psychiatric Nursing*,32(6), 786-792. doi:10.1016/j.apnu.2018.06.001

Nagai, K., Tamaki, K., Kusunoki, H., Wada, Y., Tsuji, S., Itoh, M., . . . Shinmura, K. (2018). Isotemporal substitution of sedentary time with physical activity and its associations with frailty status. *Clinical Interventions in Aging,Volume 13*, 1831-1836. doi:10.2147/cia.s175666

ParticipACTION. The Brain + Body Equation: Canadian kids need active bodies to build their best brains. *The 2018 ParticipACTION Report Card on Physical Activity for Children and Youth*. Toronto: ParticipACTION; 2018.

Pelfrey, W. V., & Weber, N. (2014). Talking smack and the telephone game: conceptualizing cyberbullying with middle and high school youth. *Journal of Youth Studies*, 17(3), 397–414.

Prot, S., Gentile, D. A., Anderson, C. A., Suzuki, K., Swing, E., Lim, K. M., … Pan Lam, B. C. (2014). Long-Term Relations Among Prosocial-Media Use, Empathy, and Prosocial Behavior. *Psychological Science*, 25(2), 358–368.

Range, L., Embry, T., & MacLeod, T. (2001). Active and passive consent: A comparison of actual research with children. *Ethical Hum Sci Serv,3*(1), 23-31.

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, 55(1), 68–78.

Ryan, R. M., & Deci, E. L. (2008). A Self-Determination Theory Approach to Psychotherapy: The Motivational Basis for Effective Change. CANADIAN PSYCHOLOGY, (3), 186.

Ryan, R. M., & Deci, E. L. (2017). Self-Determination Theory : Basic Psychological Needs in Motivation, Development, and Wellness. [Place of publication not identified]: The Guilford Press.

Sampasa-Kanyinga, H., Hamilton, H. A., & Chaput, J. (2018). Use of social media is associated with short sleep duration in a dose-response manner in students aged 11 to 20 years. *Acta Paediatrica,107*(4), 694-700. doi:10.1111/apa.14210

Saunders, T. J., & Vallance, J. K. (2016). Screen Time and Health Indicators Among Children and Youth: Current Evidence, Limitations and Future Directions. *Applied Health Economics and Health Policy,15*(3), 323-331. doi:10.1007/s40258-016-0289-3

Shakya, H. B., & Christakis, N. A. (2017). Association of Facebook Use With Compromised Well-Being: A Longitudinal Study. *American Journal of Epidemiology*, 185(3), 203-211. doi:10.1093/aje/kww189

*2014-2015 SHAPES-PEI School Health Action Planning and Evaluation System/ Prince Edward Island Student Health Profile* (pp. 1-15, Rep.). (2015).

Silke, C., Brady, B., Boylan, C., & Dolan, P. (2018). Factors influencing the development of empathy and pro-social behaviour among adolescents: A systematic review. *Children and Youth Services Review*. doi:10.1016/j.childyouth.2018.07.027

Springer, A. E., Kelder, S. H., & Hoelscher, D. M. (2006). Social support, physical activity and sedentary behavior among 6th-grade girls: a cross-sectional study. *International Journal of Behavioral Nutrition & Physical Activity, 3*, 1–10.

Strangor, C., Jhangiani, R., & Tarry, H. (2014). Principles of Social Psychology- 1st International Edition.

Tang, S., & Patrick, M. E. (2018). Technology and interactive social media use among 8th and 10th graders in the U.S. and associations with homework and school grades. *Computers in Human Behavior*, 86, 34-44. doi:10.1016/j.chb.2018.04.025

Teychenne, M., Abbott, G., Lamb, K. E., Rosenbaum, S., & Ball, K. (2017). Is the link between movement and mental health a two-way street? Prospective associations between physical activity, sedentary behaviour and depressive symptoms among women living in socioeconomically disadvantaged neighbourhoods. *Preventive Medicine,102*, 72-78. doi:10.1016/j.ypmed.2017.07.005

Tremblay, M. S., Aubert, S., Barnes, J. D., Saunders, T. J., Carson, V., Latimer-Cheung, A. E., . . . Chinapaw, M. J. (2017). Sedentary Behavior Research Network (SBRN) – Terminology Consensus Project process and outcome. *International Journal of Behavioral Nutrition and Physical Activity,14*(1). doi:10.1186/s12966-017-0525-8

Uhls, Y. T., Michikyan, M., Morris, J., Garcia, D., Small, G. W., Zgourou, E., & Greenfield, P. M. (2014). Five days at outdoor education camp without screens improves preteen skills with nonverbal emotion cues. Computers in Human Behavior,39, 387-392. doi:10.1016/j.chb.2014.05.036

Walsh, J. J., Barnes, J. D., Cameron, J. D., Goldfield, G. S., Chaput, J., Gunnell, K. E., . . . Tremblay, M. S. (2018). Associations between 24 hour movement behaviours and global cognition in US children: A cross-sectional observational study. *The Lancet Child & Adolescent Health*,2(11), 783-791. doi:10.1016/s2352-4642(18)30278-5

Williams, K., Chambers, M., Logan, S., & Robinson, D. (1996). Association of common health symptoms with bullying in primary school children. *British Medical Journal*, 313(7048), 17-19. doi:10.1136/bmj.313.7048.17

Wilmer, H.H., Sherman, L.E., Chein, J.M. (2017). Smartphones and cognition: a review of research exploring the links between mobile technology habits and cognitive functioning. *Front Psychol* 2017; 8: 1–16.

Zhaojun Teng, Qian Nie, Cheng Guo, Qian Zhang, Yanling Liu, & Bushman, B. J. (2019). A Longitudinal Study of Link Between Exposure to Violent Video Games and Aggression in Chinese Adolescents: The Mediating Role of Moral Disengagement. Developmental Psychology, 55(1), 184–195.

# APPENDICES

Table 8. ISM results for assessing the relative risk of having been bullied by others by cyber-attack at all in the last 30 days.

| | All participants | | Boys | | Girls | |
|---|---|---|---|---|---|---|
| | RR (95% CI) | P value | RR (95% CI) | P value | RR (95% CI) | P value |
| Replacing TV with: | n=5027 | | n=2429 | | n= 2598 | |
| Computer/ Video Games | .93 (.85, 1.02) | .15 | .93 (.79, 1.09) | .36 | 1.06 (.93, 1.19) | .39 |
| Talking on Phone | 1.22 (1.11, 1.33) | <.01 | 1.20 (1.00, 1.44) | .05 | 1.23 (1.11, 1.36) | <.01 |
| Surfing Internet | 1.24 (1.13, 1.36) | <.01 | 1.15 (.96, 1.37) | .12 | 1.27 (1.14, 1.42) | <.01 |
| Reading for Fun | .97 (.88, 1.07) | .55 | .97 (.80, 1.18) | .77 | .95 (.84, 1.07) | .36 |
| Replace Computer/ Video Games with: | n=5039 | | n=2434 | | n=2605 | |
| TV | 1.08 (.98, 1.18) | .11 | 1.08 (.92, 1.28) | .35 | .96 (.85, 1.08) | .49 |
| Talking on the Phone | 1.30 (1.21, 1.41) | <.01 | 1.30 (1.13, 1.50) | <.01 | 1.17 (1.05, 1.30) | .01 |
| Surfing Internet | 1.32 (1.21, 1.43) | <.01 | 1.23 (1.05, 1.45) | .01 | 1.20 (1.07, 1.34) | <.01 |
| Reading for Fun | 1.04 (.95, 1.15) | .39 | 1.05 (.89, 1.24) | .56 | .91 (.79, 1.04) | .16 |
| Replace talking on the phone with: | n=5062 | | n=2451 | | n=2611 | |
| TV | .83 (.75, .91) | <.01 | .83 (.70, 1.00) | .05 | .82 (.74, .91) | <.01 |
| Computer/ Video Games | .77 (.71, .82) | <.01 | .77 (.67, .88) | <.01 | .86 (.77, .96) | .01 |
| Surfing Internet | 1.01 (.92, 1.11) | .85 | .96 (.81, 1.14) | .66 | 1.02 (.91, 1.14) | .75 |
| Reading for fun | .80 (.73, .87) | <.01 | .81 (.69, .94) | .01 | .77 (.70, .86) | <.01 |
| | | | | | | |
| Replace internet with: | n=5055 | | n=2443 | | n=2612 | |
| TV | .81 (.74, .89) | <.01 | .86 (.72, 1.02) | .09 | .80 (.71, .89) | <.01 |
| Computer/Video Games | .76 (.70, .83) | <.01 | .80 (.68, .94) | .01 | .84 (.75, .94) | <.01 |
| Talking on the Phone | .99 (.90, 1.09) | .86 | 1.04 (.88, 1.23) | .62 | .98 (.88, 1.10) | .72 |
| Reading for Fun | .79 (.72, .87) | <.01 | .85 (.73, 1.00) | .05 | .76 (.67, .85) | <.01 |

| Replace reading with: | n=5030 | | n=2429 | | n=2601 | |
|---|---|---|---|---|---|---|
| TV | 1.04 (.94, 1.15) | .50 | 1.03 (.85, 1.25) | .78 | 1.06 (.94, 1.20) | .32 |
| Computer/Video Games | .96 (.88, 1.06) | .45 | .95 (.81, 1.12) | .57 | 1.11 (.97, 1.28) | .13 |
| Talking on the Phone | 1.25 (1.15, 1.37) | <.01 | 1.23 (1.06, 1.44) | .01 | 1.30 (1.17, 1.44) | <.01 |
| Surfing the internet | 1.27 (1.16, 1.40) | <.01 | 1.18 (1.01, 1.40) | .04 | 1.34 (1.18, 1.51) | <.01 |

Table 9. ISM results for assessing the relative risk of having bullied others by cyber-attack at all in the last 30 days.

| | All participants | | Boys | | Girls | |
|---|---|---|---|---|---|---|
| | RR (95% CI) | P value | RR (95% CI) | P value | RR (95% CI) | P value |
| Replacing TV with: | n=5021 | | n=2426 | | n=2595 | |
| Computer/ Video Games | 1.07 (.93, 1.23) | .35 | .86 (.68, 1.08) | .18 | 1.30 (1.03, 1.64) | .03 |
| Talking on Phone | 1.18 (1.01, 1.38) | .04 | 1.16 (.92, 1.47) | .21 | 1.20 (.98, 1.47) | .08 |
| Surfing Internet | 1.13 (.97, 1.31) | .11 | 1.02 (.83, 1.26) | .83 | 1.36 (1.07, 1.73) | .01 |
| Reading for Fun | .73 (.60, .90) | <.01 | .76 (.62, 1.01) | .06 | .63 (.44, .91) | .02 |
| Replace Computer/ Video Games with: | n=5032 | | n=2430 | | n=2602 | |
| TV | .95 (.82, 1.09) | .46 | 1.15 (.92, 1.43) | .22 | .80 (.63, 1.02) | .08 |
| Talking on the Phone | 1.11 (.97, 1.26) | .12 | 1.33 (1.09, 1.62) | .01 | .95 (.76, 1.19) | .65 |
| Surfing Internet | 1.06 (.91, 1.22) | .44 | 1.172 (.92, 1.50) | .21 | 1.06 (.87, 1.29) | .57 |
| Reading for Fun | .71 (.58, .85) | <.01 | .91 (.73, 1.14) | .42 | .54 (.37, .79) | <.01 |
| Replace talking on the phone with: | n=5057 | | n=2449 | | n=2608 | |
| TV | .85 (.72, .99) | .04 | .86 (.68, 1.09) | .20 | .83 (.68, 1.02) | .07 |
| Computer/ Video Games | .90 (.79, 1.03) | .12 | .73 (.59, .91) | <.01 | 1.08 (.86, | .51 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | 1.35) | |
| Surfing Internet | .95 (.81, 1.12) | .56 | .88 (.70, 1.09) | .24 | 1.13 (.88, 1.46) | .33 |
| Reading for fun | .62 (.52, .74) | <.01 | .68 (.56, .82) | <.01 | .52 (.37, .73) | <.01 |
| | | | | | | |
| Replace internet with: | n=5049 | | n=2440 | | n=2609 | |
| TV | .88 (.76, 1.02) | .08 | .97 (.79, 1.18) | .74 | .73 (.58, .93) | .01 |
| Computer/Video Games | .94 (.82, 1.08) | .39 | .83 (.65, 1.06) | .13 | .95 (.78, 1.15) | .59 |
| Talking on the Phone | 1.03 (.88, 1.21) | .69 | 1.12 (.91, 1.39) | .29 | .87 (.68, 1.12) | .28 |
| Reading for Fun | .64 (.52, .79) | <.01 | .76 (.61, .96) | .02 | .46 (.32, .66) | <.01 |
| Replace reading with: | n=5024 | | n=2426 | | n=2598 | |
| TV | 1.36 (1.11, 1.68) | <.01 | 1.26 (.99, 1.61) | .06 | 1.58 (1.09, 2.29) | .02 |
| Computer/Video Games | 1.46 (1.20, 1.77) | <.01 | 1.09 (.87, 1.36) | .47 | 2.05 (1.39, 3.04) | <.01 |
| Talking on the Phone | 1.61 (1.34, 1.92) | <.01 | 1.47 (1.21, 1.77) | .00 | 1.90 (1.35, 2.66) | <.01 |
| Surfing the internet | 1.54 (1.24, 1.91) | <.01 | 1.29 (1.02, 1.640) | .03 | 2.16 (1.52, 3.08) | <.01 |