



## Screen time is associated with depression and anxiety in Canadian youth



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### ABSTRACT

**Objective.** This study examined the relationships between screen time and symptoms of depression and anxiety in a large community sample of Canadian youth.

**Method.** Participants were 2482 English-speaking grade 7 to 12 students. Cross-sectional data collected between 2006 and 2010 as part of the Research on Eating and Adolescent Lifestyles (REAL) study were used. Mental health status was assessed using the Children's Depression Inventory and the Multidimensional Anxiety Scale for Children—10. Screen time (hours/day of TV, video games, and computer) was assessed using the Leisure-Time Sedentary Activities questionnaire.

**Results.** Linear multiple regressions indicated that after controlling for age, sex, ethnicity, parental education, geographic area, physical activity, and BMI, duration of screen time was associated with severity of depression ( $\beta = 0.23, p < 0.001$ ) and anxiety ( $\beta = 0.07, p < 0.01$ ). Video game playing ( $\beta = 0.13, p < .001$ ) and computer use ( $\beta = 0.17, p < 0.001$ ) but not TV viewing were associated with more severe depressive symptoms. Video game playing ( $\beta = 0.11, p < 0.001$ ) was associated with severity of anxiety.

**Conclusion.** Screen time may represent a risk factor or marker of anxiety and depression in adolescents. Future research is needed to determine if reducing screen time aids the prevention and treatment of these psychiatric disorders in youth.

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### Introduction

Depression and anxiety are among the leading causes of burden of disease in youth (Patel, 2013). Epidemiological data show that 5 to 9% of adolescents are clinically depressed (U.S. Department of Health and Human Services, 1999), while 21% to 50% report depressed mood (Merikangas and Avenevoli, 2002). The prevalence of anxiety disorders in youth ranges from 12% to 20% (Costello et al., 2005), with subclinical rates paralleling those of depressed mood (Merikangas and Avenevoli, 2002). These figures are alarming given that depression and anxiety are strong predictors of a multitude of negative health and psychosocial outcomes, such as interruption in development, academic difficulties, poor interpersonal relationships, behavioral problems, low self-esteem, substance abuse, and suicide (Hawgood and De Leo, 2008;

Lemstra et al., 2008). Moreover, youth experiencing anxiety and depression are at significantly increased risk of these psychiatric conditions in adulthood (Pine et al., 1999). The World Health Organization predicts that by the year 2020, childhood and adolescent mental health problems will become one of the leading causes of morbidity, mortality, and disability among children worldwide (World Health Organization, 2001).

The use of electronic devices is a popular sedentary activity in Western society, particularly among youth. In Canada and the U.S., youth spend an average of 7 to 8 h per day engaging in sedentary screen-based activities (Active Healthy Kids Canada, 2013; Rideout et al., 2010), drastically exceeding the 2-hour recommended daily maximum (American Academy of Pediatrics, 2013; Tremblay et al., 2011). The pervasiveness of screen time among adolescents is of concern given its demonstrated association with obesity (Andersen et al., 1998; Gortmaker et al., 1996), cardiometabolic risk (Andersen et al., 2006; Carson and Janssen, 2011; Goldfield et al., 2011a; Hardy et al., 2010), and diabetes (Bowman, 2006; Jakes et al., 2003). However, previous research examining the relationship between sedentary screen-based activities and mental health in adolescents is sparse and has yielded mixed

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results: some studies have shown a positive association with anxiety or depression (Cao et al., 2011; Kremer et al., 2013; Mathers et al., 2009; Primack et al., 2009; Sund et al., 2011), and others have not (Casiano et al., 2012; Hume et al., 2011). While all studies statistically controlled for the confounding effects of socio-demographic factors, only two (Mathers et al., 2009; Rosen et al., 2014) accounted for BMI and physical activity. These are important methodological limitations since screen time has been previously associated with increased adiposity and reduced physical activity levels in youth (Marshall et al., 2004), and obesity and physical activity are well documented risk and protective factors, respectively, for anxiety and depression in youth (De Moor et al., 2006; Goldfield et al., 2011b; Roberts et al., 2003).

Given that the use of electronic media devices (typically sedentary) is rampant among youth in Western (Active Healthy Kids Canada, 2013; Rideout et al., 2010) and other industrialized societies (Rey-López et al., 2010; Martin, 2011), and that symptoms of depression and anxiety are prevalent in this age group (Costello et al., 2005; Patel, 2013), further examination of the relationship between sedentary screen time and mental health in youth is warranted. Moreover, given that youth spend more time on the computer and playing video games, compared to watching TV (Active Healthy Kids Canada, 2013; Rideout et al., 2010), and that little is known on how specific screen time activities relate to mental health (Casiano et al., 2012; Mathers et al., 2009), further inquiry is needed. Elucidating a better understanding of any association between duration and types of screen time behaviors and mental health may be critical to developing more effective strategies to prevent or treat anxiety and depression in youth.

The present study aimed to examine the relationships between sedentary screen time and symptoms of depression and anxiety in a large community sample of Canadian youth. It was hypothesized that longer duration of screen time would be associated with more severe symptoms of depression and anxiety, after controlling for a wide set of possible confounders. The effects of the type of screen behavior (TV, video games, computer use) on depression and anxiety symptomatology were also examined as secondary objectives.

## Methods

### Participants

Participants were 2482 English-speaking grade 7 to 12 students (1048 males and 1434 females), ranging in age from 11.08 to 20.75 years ( $M = 14.10$  years,  $SD = 1.57$ ). Data were collected between 2006 and 2010 as part of a larger study, i.e. the Research on Eating and Adolescent Lifestyles (REAL) study, which was originally conceived to test a psychosocial model expected to predict eating and weight disorders in a community sample of adolescents. This study was approved by the relevant institutional research ethics boards.

### Procedure

All schools within three school boards and several private schools in the capital region of Canada (Ottawa, Ontario) were invited to participate. Based on schools' interest and feasibility, a total of 31 schools permitted study recruitment in one or several of their classrooms, representing a school participation rate of approximately 34%. Signed informed consent was obtained from students and their parents, and small incentives were provided to participants (pizza party or lottery for gift certificates). The overall student participation rate was 45%. The survey was conducted during regularly scheduled class time under the supervision of research staff, who upon survey completion, took objective measures of participants' height and weight in a private area. A more detailed description of the study procedure has been published elsewhere (Goldfield et al., 2011b).

### Measures

#### Demographics

Socio-demographic information included sex, age, school, grade, mother's and father's education level, ethnic background of the family, and language spoken at home.

#### Sedentary screen time

The Leisure-Time Sedentary Activities 6-item questionnaire was designed by the investigators to measure how many hours per day respondents typically engage in: TV viewing, video game playing, and computer use. Scores range from 0 to 5, where 0 = not at all; 1 = less than 1 h; 2 = 1 to 3 h; 3 = 3 to 5 h; 4 = 5 to 8 h; and 5 = more than 8 h. The first three items address time spent engaging in screen-based activities during a typical week day, and the last three items assess screen time accrued on a typical weekend day. Total screen time and time spent on each specific screen activity were weighted as follows:  $[(\text{week day} \times 5) + (\text{weekend} \times 2)] / 7$ . Higher scores are representative of more time engaged in sedentary screen-based activities; note that the raw score does not represent the number of hours of screen-time.

#### Depression

The Children's Depression Inventory (CDI) is a self-report questionnaire consisting of 27 items reflecting cognitive, affective, and behavioral signs of depression (Kovacs, 1992). Each item is assigned a score from 0 to 2, with the higher number being attributed to the most depressive statement (Kovacs, 1992). The total score ranges from 0 to 54. This widely used inventory has ample evidence supporting its psychometric properties, with high internal consistency ( $r = .71$  to  $r = .89$ ), and test-retest reliability ( $r = .50$  to  $r = .83$ ), and good concurrent validity (Kovacs, 1992). In the present study, Cronbach's alpha for the total score was .89.

#### Anxiety

The Multidimensional Anxiety Scale for Children—10 (MASC-10) is a 10-item, 4-point Likert-style, self-report scale that is a short and efficient global measure of anxiety symptoms (March and Sullivan, 1999). The MASC-10 is a uni-factorial scale that evaluates anxiety symptoms across the four basic anxiety dimensions assessed by the original (39-item) MASC (physical symptoms, harm avoidance, social anxiety and separation anxiety/panic) (March et al., 1997). The MASC-10 has demonstrated satisfactory internal reliability and excellent stability in adults and youth (March and Sullivan, 1999; Osman et al., 2008). Cronbach's alpha in the present sample was .76.

#### Physical activity

The Godin Leisure-Time Exercise Questionnaire (GODIN) measures how often participants engage in strenuous, moderate, and mild exercise for more than 15 min at a time, and has been shown to be reliable and valid with test-retest reliability coefficients as high as  $r = 0.94$  (Godin and Shephard, 1985). In this study, the total volume of physical activity was calculated as follows: (frequency of mild exercise  $\times$  3 METS (metabolic equivalent of task) + (frequency of moderate exercise  $\times$  5 METS) + (frequency of strenuous exercise  $\times$  9 METS). Higher total scores are indicative of more volume of exercise. Sedentary behavior is conceptually and empirically distinct from a lack of physical activity (Hamilton et al., 2004; Healy et al., 2008), and physical activity has been associated with decreased anxiety and depression (De Moor et al., 2006). Thus, physical activity was controlled for in the present study to better isolate the association between screen time and symptoms of anxiety and depression.

#### Covariates

Age, sex, ethnicity, parental education, and school geographic area were included as covariates. Height and weight were measured using an HM200P Portable Stadiometre (Quick Medical Equipment and Supplies, U.S.A.), and a UC-321 Digital Weighing Scale, respectively (Quick Medical Equipment and Supplies, U.S.A.). BMI was calculated by dividing weight in kilograms (kg) by height in squared meters ( $m^2$ ), and was also statistically controlled for because increased BMI has been associated with increased symptoms of depression (Goldfield et al., 2010) and anxiety (Van Reedt Dortland et al., 2013).

#### Statistical analysis

All variables were examined for outliers and normality, and all assumptions for multiple regression were met. To test whether total sedentary screen time (hours per day spent watching TV + recreational computer use + video games) was associated with more severe symptoms of depression and anxiety, two separate multiple linear regressions were conducted, controlling for: age (years), sex (0 = female, 1 = male), ethnicity (0 = Caucasian, 1 = other), parental education (0 = neither parent completed college, 1 = at least one parent completed college or higher), geographic area of school (0 = urban, 1 =

suburban, 2 = rural), BMI, and physical activity (total score). Additional multiple linear regressions were conducted to examine the relative contribution of each type of sedentary screen-based activity (i.e., TV viewing, video game playing, and computer use) on anxiety and depression symptoms, controlling for the same covariates. Analyses were conducted using the statistical package for the social sciences (SPSS Inc., New York) version 21.0, with an alpha level of 0.05.

**Results**

Sample characteristics are presented in Tables 1 and 2. Bivariate correlations between variables of interest are shown in Table 3. The sample was approximately evenly comprised of males (42.2%) and females (57.8%). The majority had at least one parent who completed college (87.2%), and about two thirds were Caucasian (72.1%). Mean depression and anxiety raw scores were below the clinical cut-off values generally used for depression (22 to 28) and anxiety (16 to 21). Screen time rates were slightly below average compared to Canadian youth in other epidemiological studies (Active Healthy Kids Canada, 2013), but still greatly exceeded the recommended 2 h per day maximum of total screen time (Tremblay et al., 2011).

Results of the regression predicting symptoms of depression are presented in Table 4. The overall model was significant after controlling for covariates,  $F_{(8,1513)} = 25.81, p < 0.001$ , with  $R^2$  at .120 (adjusted  $R^2 = .115$ ). Duration of total screen time was significantly associated with depressive symptoms, controlling for age, sex, ethnicity, parental education, BMI, and physical activity.

Results of the regression predicting symptoms of anxiety are presented in Table 5. The overall model was significant after controlling for covariates,  $F_{(8,1472)} = 14.55, p < 0.001$ , with  $R^2$  at .073 (adjusted  $R^2 = .068$ ), and duration of total screen time was significantly associated with severity of anxiety symptoms, after controlling for covariates.

The contribution of each of the three sedentary screen-based activities on depression and anxiety was explored using linear regression, while controlling for the aforementioned covariates and the other two screen-based activities (see Table 6). Time spent playing video games [ $F_{(10,1511)} = 21.71, p < 0.001$ , with  $R^2$  at .126 (adjusted  $R^2 = .120$ )], and time spent using the computer [ $F_{(10,1511)} = 21.71, p < 0.001$ , with  $R^2$  at .126 (adjusted  $R^2 = .120$ )] were significantly associated with more severe symptoms of depression, while time spent playing video games emerged as a significant predictor of more severe symptoms of anxiety [ $F_{(10,1470)} = 12.66, p < 0.001$ , with  $R^2$  at .079 (adjusted  $R^2 = .073$ )].

**Discussion**

To our knowledge, the present study is the first to examine the relationship between sedentary screen-based activity and symptoms of depression and anxiety in a large community sample of Canadian adolescents. Results indicate that time spent engaging in sedentary screen-based activities was significantly associated with severity of depression and anxiety, after controlling for relevant covariates. Regarding the type of screen time behavior, video game playing and computer use

**Table 1**  
Sample characteristics.

Indicator	n	M	SD	Range
Age (years)	2282	14.10	1.57	11.08–20.75
Body mass index (kg/m <sup>2</sup> )	2444	21.03	3.66	14.14–35.95
Physical activity (GODIN total score)	2180	61.76	37.94	0–262.0
Depression (CDI total score)	2353	7.80	6.97	0–39.0
Anxiety (MASC-10 total score)	2299	10.09	5.16	0–27.0

CDI = Children's Depression Inventory; GODIN = Godin Leisure-Time Exercise Questionnaire; MASC-10 = Multidimensional Anxiety Scale for Children–10. Data were collected in the national capital region of Canada between 2006 and 2010.

**Table 2**  
Sample characteristics.

Indicator	n (%)	
Sex (n = 2482)		
Male	1048	(42.2)
Female	1434	(57.8)
Parent education (n = 2097)		
Neither parent completed college	269	(12.8)
At least one parent completed college	1828	(87.2)
Ethnicity (n = 2097)		
Caucasian	1754	(72.1)
Other	680	(27.9)
School geographic setting (n = 2482)		
Urban	699	(28.2)
Suburban	1353	(54.5)
Rural	430	(17.3)
Screen activities	Weekday	Weekend
Television viewing		
None	138 (6.5)	50 (2.3)
Less than 1 hour	624 (29.2)	309 (14.5)
1 to 3 h	1043 (48.9)	964 (45.2)
3 to 5 h	261 (12.2)	599 (28.1)
5 to 8 h	55 (2.6)	148 (6.9)
More than 8 h	13 (0.6)	63 (3.0)
Video/computer game playing		
None	670 (31.5)	558 (26.3)
Less than 1 h	820 (38.5)	585 (27.5)
1 to 3 h	475 (22.3)	587 (27.6)
3 to 5 h	120 (5.6)	259 (12.2)
5 to 8 h	31 (1.5)	91 (4.3)
More than 8 h	14 (0.7)	45 (2.1)
Computer use		
None	129 (6.1)	142 (6.7)
Less than 1 h	702 (32.9)	510 (24.0)
1 to 3 h	858 (40.3)	777 (36.5)
3 to 5 h	321 (15.1)	438 (20.6)
5 to 8 h	96 (4.5)	182 (8.5)
More than 8 h	25 (1.2)	80 (3.8)

Data were collected in the national capital region of Canada between 2006 and 2010.

were significantly associated with depressive symptoms, while only video gaming was significantly associated with anxiety.

Our finding of an association between screen time and depressive symptoms among Canadian youth is consistent with results from several studies using large cohorts of adolescents from the U.S. (Primack et al., 2009), China (Cao et al., 2011), Norway (Sund et al., 2011), and Australia (Kremer et al., 2013; Mathers et al., 2009). However, two other studies showed no association between screen time and depression (Casiano et al., 2012; Hume et al., 2011); one had a relatively small sample size, therefore lack of power may have contributed to the null findings (Hume et al., 2011), while the other utilized a clinical interview to diagnose major depressive disorder, thus not including subclinical levels of depressive symptoms (Casiano et al., 2012). Few studies have examined

**Table 3**  
Correlations between variables of interest.

	1	2	3	4	5	6	7
1. Body mass index	–						
2. Physical activity	.028	–					
3. Depression	.116**	–.062**	–				
4. Anxiety	–.006	–.122**	.365**	–			
5. Television	.091**	–.065**	.130**	.075**	–		
6. Video games	.009	.027	.103**	–.009	.285**	–	
7. Computer	.054*	–.028	.266**	.059**	.299**	.189**	–
8. Total screen time	.067**	–.025	.212**	.054*	.706**	.714**	.709**

Data were collected in the national capital region of Canada between 2006 and 2010.

\*  $p \leq .05$ , two-tailed.  
\*\*  $p \leq .01$ , two-tailed.



**Table 4**  
Linear multiple regression analysis of total sedentary screen time predicting symptoms of depression.

	B	SE	$\beta$	t	p	95% CI
<i>Block 1</i>						
Age	.691	.107	.165	6.432	<.001	.480, .902
Sex (0 = female; 1 = male)	-1.268	.356	-.090	-3.563	<.001	-1.966, -.570
Ethnicity	.147	.377	.010	.391	.696	-.591, .886
Parent education	-1.925	.520	-3.703	-3.703	<.001	-2.945, -.905
School location	-.042	.263	-.004	-.159	.873	-.558, .474
Body mass index	.117	.047	.063	2.498	.013	.025, .208
Physical activity	-.008	.005	-.042	-1.685	.092	-.017, .001
<i>Block 2</i>						
Screen time	.807	.087	.230	9.329	<.001	.637, .977

Note: CI, confidence interval; sex (0 = females, 1 = males), ethnicity (0 = Caucasian, 1 = other), parent education (0 = neither parent completed college, 1 = at least one parent completed college), BMI; school geographic location (0 = urban, 1 = suburban, 2 = rural); screen time (weighted average of time spent engaged in TV, video games, and computer use on weekdays and weekends). Data were collected in the national capital region of Canada between 2006 and 2010. Bold text indicates statistical significance.

the association between screen time and anxiety in youth. Our finding that screen time was associated with more severe symptoms of anxiety is consistent with results from a study in a large sample of adolescents from China (Cao et al., 2011), but not with youth from Australia (Mathers et al., 2009).

There is little research evidence yet on the relationships between specific types of screen behavior and depression or anxiety in adolescents. Such relationships are important to investigate given that time spent in recreational computer use and video gaming may be more prevalent than time watching TV among North American youth (Active Healthy Kids Canada, 2013; Rideout et al., 2010). Our finding that time watching TV was not significantly associated with symptoms of depression is consistent with findings by Mathers et al. (2009) and Casiano et al. (2012), while Primack et al. (2009) found TV viewing was related to depression. These discrepant findings could be due to methodological differences across studies, including covariates and measurement of outcome variables. Research on anxiety and TV viewing in youth is sparse. In a sample of 925 adolescents in Australia, no association was found (Mathers et al., 2009), consistent with our findings.

We found that time spent playing video games was significantly associated with symptoms of depression and anxiety. This is in line with an Australian study that included symptoms of depression and anxiety together in a global measure (Kessler-10 (Kessler et al., 2002)), but did not differentiate between these symptoms (Mathers et al., 2009). Our findings are also in accordance with research examining

**Table 5**  
Linear multiple regression analysis of weighted total sedentary screen time predicting symptoms of anxiety.

	B	SE	$\beta$	t	p	95% CI
<i>Block 1</i>						
Age	.156	.082	.050	1.893	.059	-.006, .318
Sex	-2.310	.273	-.223	-8.450	<.001	-2.846, -1.774
Ethnicity	-.115	.290	-.010	-.397	.691	-.684, .453
Parent education	.088	.399	.006	.220	.826	-.694, .870
School location	.000	.202	.000	.002	.999	-.395, .396
Body mass index	-.038	.036	-.028	-1.070	.285	-.108, .032
Physical activity	-.013	.003	-.094	-3.633	<.001	-.019, -.006
<i>Block 2</i>						
Screen time	.191	.066	.074	2.899	.004	.062, .320

Note: CI, confidence interval; sex (0 = females, 1 = males), ethnicity (0 = Caucasian, 1 = other), parent education (0 = neither parent completed college, 1 = at least 1 parent completed college); school geographic location (0 = urban, 1 = suburban, 2 = rural); screen time (weighted average of time spent engaged in TV, video games, and computer use on weekdays and weekends). Data were collected in the national capital region of Canada between 2006 and 2010. Bold text indicates statistical significance.

multiplayer online gaming behavior, which has been associated with anxiety and negative mood (Cole and Hooley, 2013; Lo et al., 2005), and with research demonstrating that excessive video game playing and internet use were significantly associated with sadness and suicidality (Messias et al., 2011). Conversely, a study among 9137 adolescents found that video game playing was cross-sectionally associated with lower rates of depression (anxiety was not examined) (Casiano et al., 2012). Discrepancy with other findings might relate to the outcome variable being 'probability of major depression' or a combined measure of depression and anxiety, and not controlling for physical activity.

In the current study, computer time was associated with symptoms of depression but not anxiety, while Casiano et al. (2012) did not find an association between computer use and depression (anxiety was not examined). Similarly, a study from the U.S. found that computer use and time spent surfing the web were not associated with depression, and predicted increased anxiety only for adolescents with an alcoholic parent (McCauley, 2009). Mathers et al. (2009) found a protective relationship between computer use and psychological distress in youth. Thus, results are mixed regarding the effects of computer time on mental health in youth, perhaps due to methodological differences across studies.

There are many possible explanations for the relationship between increased screen time and poorer psychological health in youth. Screen-based activities could displace time otherwise spent fostering healthy interpersonal relationships. Researchers have acknowledged that youth who spend large amounts of time engaging in screen-based activities may be socially isolating themselves (Bohnert and Garber, 2007; McHale et al., 2001). Moreover, it is well known that a healthy attachment orientation is crucial to healthy development (Scharfe and Eldredge, 2001), and increased screen time can have a negative effect on attachment relationships, which can negatively impact mood (Richards et al., 2010). Another mechanism could relate to the nature of the content, situation, or messaging of the screen exposure. For example, computer/internet use may expose youth to cyber-bullying, and it has been shown that depression and anxiety are correlates of cyber-bullying among youth (Kowalski and Limber, 2013). Also, as posited by social comparison theory and objectification theory (Fredrickson and Roberts, 1997), exposure to unattainable images that objectify the human body may contribute to feelings of depression and anxiety (Dakanalis et al., 2013; Tiggemann and Kuring, 2004). Also, adolescents who spend more time in front of electronic screens have more sleeping problems (Nelson and Gordon-Larsen, 2006; Van den Bulck, 2004), which could compromise their ability to cope with stress, resulting in increased feelings of depression or anxiety. Finally, screen time can also displace time spent engaging in physical activity, which is concerning given previous findings that physical activity is associated with decreased anxiety and depression symptoms (De Moor et al., 2006; Dunn et al., 2001; Ströhle, 2009).

### Study limitations and strengths

Several limitations of the current study should be recognized. First, the cross-sectional design limits the ability to make causal inferences about the observed relationships. Theoretically, because children and youth engage in sedentary screen-based behaviors from a very young age, sedentary screen time behaviors could precede the development of depression and anxiety symptoms. The reverse may also be true since youth with symptoms of depression and/or anxiety may spend disproportionately more time engaging in screen-based activities, perhaps as a maladaptive coping strategy. Indeed, prospective data highlight the potential for bidirectional influences, with two studies showing that screen time predicted depression in adolescents (Primack et al., 2009; Sund et al., 2011), while another found that depression predicted screen time usage (Hume et al., 2011). Future research should probe the times of the day youth engage in these

**Table 6**  
Associations of screen time behaviors and anxiety and depressive symptoms.

	Television			Video games			Computer		
	B	$\beta$	95% CI	B	$\beta$	95% CI	B	$\beta$	95% CI
Depression	0.23	0.028	−0.20, 0.67	0.89	0.13	0.51, 1.27*	1.21	0.17	0.85, 1.58*
Anxiety	0.17	0.03	−0.15, 0.50	0.56	0.11	0.27, 0.85*	−0.13	−0.03	−0.41, 0.15

Note: CI, confidence interval; Each linear regression controlled for age, sex (0 = females, 1 = males), ethnicity (0 = Caucasian, 1 = other), parental education (0 = neither parent completed college, 1 = at least one parent completed college), school geographic location (0 = urban, 1 = suburban, 2 = rural), BMI, physical activity, and the other two types of screen time behavior. Data were collected in the national capital region of Canada between 2006 and 2010.

\*  $p < 0.001$ .

activities, and examine what specific types of media and information they access. Future studies should also include objective measures of physical activity, and objective and continuous measures of screen time. Lastly, not all schools and participants approached for the current study consented to participate, but the fact that the socio-demographic characteristics of the large community-based sample closely resemble those for the entire Ottawa area (see recent Canada Census data (Statistics Canada, 2007)) supports the generalizability of the study findings.

Limitations are balanced with several strengths of the current study. Height and weight were objectively measured, which decreases the possibility of any bias in self-reported BMI, an important covariate. Compared to previous research, the present study utilized the largest number of covariates, strengthening the internal validity of the findings. Specifically, very few studies on sedentary screen time and mental health have controlled for physical activity. Finally, depression and anxiety were assessed using well-validated questionnaires, and as separate constructs, allowing for differential associations between screen-based activities and psychological symptoms to emerge.

## Conclusion

The present study makes a unique contribution to the limited existing research examining how sedentary screen-based activities may relate to symptoms of depression and anxiety in youth. Our data indicate that duration of sedentary screen time was associated with more severe symptoms of depression and anxiety in a large sample of Canadian adolescents. This suggests that screen time may represent a risk factor for, or a marker of these psychiatric disorders among youth. Thus, physicians and other medical and mental health practitioners should inquire about screen time in their assessment of children and adolescents seeking treatment for anxiety or depression, as this may inform treatment planning. In addition, our findings could help better inform sedentary behavior guidelines for children and adolescents, by including information on the potential psychiatric risks of excessive sedentary screen-based activities. Longitudinal studies examining the relationship between screen time and mental health are warranted. Moreover, while research has shown that reducing screen time can reduce adiposity in obese children (Goldfield et al., 2002), our findings support the conduct of randomized controlled trials to determine if reducing screen time can also have a significant impact on the prevention and treatment of anxiety and depression in adolescents.

## Conflict of interest statement

Danijela Maras, Martine F. Flament, Nicole Obeid, Marisa Murray, Annick Buchholz, Katherine A. Henderson, and Gary Goldfield declare that there are no conflicts of interest.

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