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Do school physical activity policies and programs have a role in decreasing multiple screen time behaviours among youth?

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Title: Do school physical activity policies and programs have a role in decreasing multiple screen time behaviours among youth?

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ABSTRACT

Screen time in youth has been associated with a wide range of poor health outcomes. Evidence indicates the need to develop physical activity (PA) school policies and programs that are aimed at decreasing youth screen time behaviours. This study aims to understand the association between PA policies and programs embedded into the functioning of 89 schools across two provinces in Canada and multiple screen time behaviours.

As part of the COMPASS Study, a total of 44,861 youth aged between 13 and 18 years and belonging to 89 schools in two Canadian provinces completed a validated questionnaire for health behaviours and outcomes data. PA policies and programs were measured using the School Policies and Practices Questionnaire, completed by the relevant school administrator. Participation in before-school, noon hour, or after-school intramural programs, participation in varsity sports, and access to indoor areas of PA during non-instructional time, was associated with significantly lower multiple screen time behaviours across both provinces. With exposure to multiple electronic and digital devices only predicted to increase among youth in the future, there is a need to conceptualize and integrate school-based screen time reducing PA policies and programs into the regular functioning of the schools.

Keywords: School Health; School Policies; Adolescent Health; Screen time; Physical Activity

Conflict of interest: None

INTRODUCTION

Screen time (ST) in youth has been associated with a wide range of poor health outcomes, including anxiety, depression, smoking, drunkenness, and drug use (1-9). Evidence suggests that these behaviours are associated with the increasing use of multiple electronic and digital media devices (e.g. Television (TV), desktop/laptop computers, tablets), and especially hand-held devices such as smartphones, which allow youth to constantly access social media (10,11). Constant usage of multiple electronic and digital media devices has resulted in the rise in prevalence of high ST among youth (12,13). However, most of the available evidence has focused on TV viewing, computer time/internet surfing or video games, with more recent and popular communication activities, such as texting and instant messaging using hand-held devices, being largely ignored (14-16).

ST is also used as a proxy measure for sedentary behaviour, and with sedentary behaviour being a critical determinant of health, independent of physical activity (17), and with the overwhelming majority of youth (89%) exceeding sedentary behaviour guidelines (18), there is clearly a need for more research in this domain.

Various studies indicate the need to develop school policies and programs that are aimed at improving opportunities for PA and decreasing multiple ST behaviours (13-15). Although short term (3-24 months) school-based PA policy and program interventions to reduce ST in children and youth have demonstrated moderate impact (20-22), to our knowledge, there is no research investigating how naturally evolving cross-jurisdictional school PA policies and programs are associated with ST among youth.

Evaluating such natural experiments could add substantial value to the current limited evidence-base specific to school-based sedentary behaviour programming. This study is based on the hypothesis that existing school programs and policies that promote PA can have an effect on reducing ST. Moreover, when trying to understand the association of these policies and programs with ST behaviours, it is important to take into consideration the surrounding school built and physical environments, as well as local weather, factors that are known to influence ST-based sedentary behaviours (23,24).

Controlling for built environment surrounding the schools and weather, this study aims to understand the association between PA policies and programs embedded into the functioning of 89 schools across two provinces in Canada and multiple ST behaviours (including communication-based ST behaviours such as texting, online messaging, and emailing) in youth.

MATERIALS

Design

COMPASS (2012-2021) is a longitudinal cohort study collecting data from a sample of secondary school students (grades 9 through 12), and the schools they attend in two Canadian provinces: Ontario (n=79) and Alberta (n=10) (25). This study uses secondary cross-sectional student- and school-level data from Year 2 (2013-2014) of the COMPASS cohort. (25).

Participants

Parents or guardians of eligible students were mailed an information letter or received an automated call about the COMPASS study and were asked to contact the COMPASS recruitment coordinator using a toll-free phone number or email address

should they not want their child to participate. All eligible students whose parents or guardians did not contact the COMPASS team to withdraw their child were deemed eligible to participate. Students could withdraw themselves and decline participation at any time. All procedures were approved by the University of Waterloo Office of Research Ethics and participating School Boards. In Ontario, out of a total 52,529 students enrolled in grades 9 to 12, 80.1% (N=41,734) students completed the student-level COMPASS questionnaire (Cq), and in Alberta, out of a total of 4,700 students were enrolled in grades 9 to 12, 77.1% (N=3,564) of students completed the Cq in class time on the day of their schools' scheduled data collection.

Data Collection Tools

The Cq collects individual student data pertaining to health behaviours and outcomes, including ST-based sedentary behaviour, as well students' access to, and utilization of school PA programs. Items measured on the Cq were based on national standards or current national public health guidelines.

Policies and programs related to PA were measured using the School Policies and Practices Questionnaire (SPP), a paper-based survey completed by the administrator most knowledgeable about the school program, practice, and policy environment. The SPP measures the presence or absence of relevant programs and policies, as well as changes to school programs, policies, or resources that are related to student health (25).

Data on the community built environment surrounding each COMPASS schools (1.5 kilometres circular buffers) were collected using the CanMap Route Logistics spatial information database and the Enhanced Points of Interest data resource from Desktop Mapping Technologies Inc. (DMTI) (25).

Weather and daylight data were obtained through the Environment Canada website, *Climate* database (26). The latitudinal and longitudinal coordinates for each school were identified, and weather data that were collected at the closest weather station within 50 km of each school were downloaded for analyses.

Measures

Student-level measures: All student level information was collected using the Cq, and all measures in this manuscript are consistent with previous research examining ST and sedentary behaviour in youth (16, 25). Apart from age, sex, ethnicity, and weekly allowance/income from part-time jobs, students were asked to report on the average amount of time per day they spent in each four types of ST behaviour: (1) watching/streaming TV shows or movies, (2) playing video/computer games, (3) surfing the internet, and (4) texting, messaging, emailing, via four individual items on the Cq.

To assist students with reporting the amount of time spent texting, messaging, emailing, they were given an example in which 50 texts was equivalent to 30 minutes. Students were provided with response options in hours (0 to 9) and minutes (0,15,30,45). Total ST was measured as the sum of minutes for these four activities. Previous research found that the test re-test reliability for these individual items ranged from fair (TV: ICC = 0.56) and moderate (playing video or computer games: ICC=0.65; surfing the internet: ICC = 0.71), to substantial (texting, messaging, emailing: ICC = 0.86) (26).

Cq assessed access to, and utilization of school PA programs (Table 1). For instance, students were asked if they were taking a physical education class at school that year, if they participated in before-school, noon hour, or after school PA (i.e., intramurals, non-competitive clubs) organized by the school, and if they participated in

competitive school sports competing against other schools (i.e., junior varsity or varsity sports). Students were also asked to report their height and weight (to calculate body mass index [BMI]), the number of minutes they sleep each day, and the number of hours and minutes they spend in vigorous and moderate PA per day using previously validated items (27).

School-level measures: For Ontario schools, data from the SPP administered in both Y1 (2012-2013) and Y2 were used to identify what existing policies, programs, and practices were in place. Data from the Y1 SPP were extracted, and any updates to that information derived from the Y2 SPP data were recorded. The only available SPP data for Alberta were from the Y2 SPP (its first year of participation). School level variables of interest for this study included intramural and varsity *programs*, (i.e., sports including soccer, tennis, football, wresting, swimming, curling, rugby, baseball, track, ice hockey, alpine skiing, cross country running, badminton, and rowing), as well PA policies such as *access to facilities and equipment* (indoor and outdoor) both during and outside of school hours. The remaining questions from the SPP can be found in *table 1*.

Weather and daylight data: All weather data were from 7 days prior to the Cq deployment, to match weather variables with participant recall. Data on maximum temperature (degrees Celsius [°C]), total rainfall (millimetres [mm]), total snowfall (centimetres [cm]), and total precipitation (mm) were collected. Maximum temperature (°C) was derived based on the average of the daily highest temperatures. Total precipitation was derived as the average of the daily rainfall and the water equivalent of the total snowfall (mm). Daily daylight hours were calculated by subtracting the time of

sunrise from the time of sunset; average daylight time was calculated by taking the average of daily daylight in the last 7 days prior to the date of data collection.

Built Environment Data: Data on built environment within 1.5 km of each COMPASS school, including the number of parks, open areas, sporting goods/bicycle shops, amusement/recreation services, PA facilities, amusement parks, and museum/art galleries were collected.

Analyses

All the analyses were carried out in SAS 9.4. The whole sample was divided into three groups: males in Ontario, females in Ontario, and all students in Alberta. To further investigate the association of ST activities with other student- or school- level factors, we developed five random-intercept linear regression models in each group. The 5 outcomes were total ST, TV time, video game time, internet surfing, and time spent in communication-based ST behaviours, respectively. We removed students having 24 hours of ST activity, as well as missing values for grade and sex. All models were adjusted for age, ethnicity, daylight hours and weather variables. The predictors in the final models were selected using PROC GLMSELECT and backward stepwise method based on p-values. The predictors whose effects were significant at the 0.1 level were included in the final models. Also, the outcome was subject to cubic root transformation to meet the model normality assumption. Residual plots were used to verify the model assumption. The models were adjusted for school level policy/program variables. Also, random intercept at the school level was included to account for additional variability in school policies between schools. Significance tests were conducted for each model to check if the variance of random intercept is zero by specifying COVTEST option in

PROC MIXED. Only significant random intercepts were included in the final models. Due to the limited sample size for Alberta, analyses were only stratified by sex for the Ontario sample.

RESULTS

This study included a total of 44,861 (49.37% females) participants aged between 13-18 years. Of these, 41,324 (49.33% females) were recruited from 79 schools in Ontario, and 3537 (49.78% females) were recruited from 10 schools in Alberta. Demographic and ST characteristics for all students can be found in Table 2. Total ST among females and males of both provinces was above 7.5 hours per day on average.

In terms of the weather, the average daily maximum temperature was 5.34 °C (SD: 8.78) and -8.65 °C (SD: 6.58) for Ontario and Alberta schools, respectively (P<.0001). The average of Precipitation was 2.68 mm (SD: 2.07) and 9.28mm (SD: 0.98) for Ontario and Alberta schools, respectively (P=0.0001). Finally, the average of daylight hours was 11.72 (SD: 2.27) and 9.29 (SD: 1.55) for Ontario and Alberta schools, respectively (P=0.0005).

Within-province, between-school comparison of presence/absence of school PA policies, and access/utilization of school PA programs, showed consistency across both provinces, with schools showing greater presence and access/utilization depicting significantly (Analysis of variance [ANOVA]) lower total ST per day (Table 1).

There were significant differences (PROC T-Test) in different ST behaviours between females and males in both provinces. Females in both provinces reported significantly more communication-based ST behaviours per day than any other ST behaviour (<.0001). Similarly, Females in both provinces reported significantly higher

Internet surfing time (<.0001). On the other hand, males in both provinces reported significantly more time playing video games than any other ST behaviour (<.0001).

In both Ontario (7%) and Alberta (10%), only a small proportion of youth reported ST that met current sedentary behaviour guidelines (ST of <2 hr/day), with more than 60% youth in both provinces reporting ST of 5 or more hr/day (Figures 1 and 2). In both provinces, irrespective of the amount of ST accumulated per day, males reported significantly higher moderate to vigorous PA (MVPA) per day (PROC T-Test; <0.001; Figures 3 and 4). In Ontario, males and females who reported less than 1 hour of ST per day also reported significantly higher MVPA per day (PROC T-Test in SAS 9.4; >23 minutes/day) in comparison with males and females who accumulated more than 1 hour of ST per day (<0.001).

Separate random-intercept linear regression models for Ontario males, Ontario females and total youth participants in Alberta with multiple (communication-based ST behaviours, TV viewing, video gaming, Internet surfing), and total ST behaviours revealed several patterns across cohorts of both provinces (Table 3).

Participation in before-school, noon hour, or after-school intramural programs was associated significantly less time playing video games and accumulating total ST among Ontario males. Similarly, participation in before-school, noon hour, or after-school intramural programs was associated with significantly less time watching TV and accumulating total ST among Alberta youth

Participation in varsity sports had a protective impact among all cohorts under consideration (Ontario males and females, and Alberta youth). Males in Ontario who participated in varsity sports reported significantly less time playing video games and

surfing the Internet. Females in Ontario who participated in varsity sports reported significantly less time watching TV, playing video games, Internet surfing, and accumulating total ST. Alberta youth who participated in varsity sports reported significantly less time playing video games.

Finally, access to indoor areas of PA during non-instructional time was associated with significantly less time video games among Ontario males. None of the school PA policies and programs were associated with communication-based ST behaviours in any cohorts considered in this study.

DISCUSSION

Although short duration (<2 years) school-based PA policy and program interventions to reduce ST in children and youth have demonstrated moderate impact (20-22), to our knowledge, there is no research investigating how naturally evolving cross-jurisdictional school PA policies and programs influence ST of youth. Moreover, to date, epidemiological investigations of PA and ST behaviours have rarely factored-in weather variation, a perennial variable that interacts with all other social and built environment factors to influence active living (23,24,28). This study, after factoring-in weather and built environment, aimed to examine the association between existing PA policies and programs in 89 schools across two provinces in Canada and multiple ST behaviours in youth.

A very small proportion of youth in both provinces (Ontario: 7%; Alberta: 10%) met existing sedentary behaviour guidelines that are based on daily total ST accumulation (<2hr/day). This proportion is much lower in comparison with previous observations in Canadian youth and internationally representative samples, where the percentage of

youth who met ST guidelines ranged from 14 to 33% (12,13). This discrepancy is probably due to the inclusion of communication-based ST as one of the ST behaviours in our study, which increased the total ST reported by youth.

Until now, most studies measuring ST have predominantly considered only TV and computer time, where computer time included both Internet surfing and video gaming (12,13). It is important to not only segregate these individual ST behaviours, but also to account for communication-based ST behaviours such as texting, online messaging and emailing to capture the complete picture of youth ST accumulation in today's world (14,16).

In terms of interventions to minimize ST, PA plays a critical role because youth engagement in MVPA has not only been associated with lower total ST in youth, but also in the reduction in daily time available to engage in ST behaviours (29, 30). For example, in our study, males and females in Ontario who reported less than 1 hour of ST per day also reported significantly greater accumulation of MVPA.

Schools play a central role in providing opportunities for youth to be physically active, and evidence indicates that policies such as physical education during school hours increase the chances of accumulating higher levels of MVPA among youth (31). Moreover, written school policies with options for organized non-curricular PA several times a week significantly increases youth PA, even after controlling for individual and environmental factors, as shown in a nationally representative sample of Norwegian secondary schools (32).

A comparison of presence/absence of school PA policies across both provinces in our study showed that in Ontario, students in schools that provided indoor and outdoor

PA areas, equipment and infrastructure, reported significantly lower ST/day in comparison with schools without these policies, a finding that shows the importance of school PA policies in reducing ST (33). This comparison of school policies was not possible across Alberta with respect to some policies (indoor and outdoor PA areas), as all schools in Alberta implemented them. Where comparison was possible between schools with the presence/absence of PA policies (PA equipment and infrastructure), significant differences between schools were not observed potentially due to the low sample size of schools in Alberta.

However, patterns of ST/day across both provinces were similar when utilization of school PA programs was compared, with students who reported higher utilization showing lower ST/day in both provinces. Alberta and Ontario are provinces situated in the west and east of Canada, respectively, with distinct geographic and climatic conditions (26). Moreover, significantly different weather conditions were observed in Alberta and Ontario during the data collection phase. Despite these distinctions, overall, the patterns of ST in general, and ST patterns in comparison with utilization/non-utilization of school PA programming, were similar across both provinces, potentially pointing towards the importance of school PA policies and programs in superseding geographic and climatic differences.

Final random-effects models (Tables 3-5) showed that, before-school, noon hour, or after-school intramural PA programs that allow youth to participate in sports in a non-competitive way, competitive varsity sports, and access to indoor areas of PA during non-instructional time were associated with lower ST accumulation among different cohorts under consideration (i.e., Ontario males, Ontario females and Alberta youth).

Current evidence indicates that youth who participate in intramural sports are more likely to be active (34). More importantly, irrespective of reporting participation in intramural sports, youth in schools with more intramural sports accumulate more overall and vigorous PA than youth who attend schools with fewer intramural sports (35). Similarly, participation in varsity sports among youth increases the likelihood of accumulating more PA (34). Although there is little evidence specific to access to indoor areas to be physically active during non-instructional school time, there is some evidence to suggest that access to indoor recreational facilities is a factor in increasing PA among youth (36).

There is an inherent interplay between PA and ST-based sedentary behaviours (23), and as the 2016 global report card on the physical activity of children and youth indicates (37), PA and ST-based sedentary behaviours are an integral part of an active living lifestyle. School PA policies and programs are critical to improving youth active living (38,39), and as indicated by our findings, school PA policies and programs, if utilized by youth appropriately, could play a key role in increasing PA and reducing ST-based sedentary behaviours.

Our study's results also suggest that school PA policies and programs when embedded into the functioning of the schools, across different jurisdictions, have a positive association with lower ST among youth, after controlling for varying weather patterns. However, with increasing youth dependence and access to multiple electronic and digital devices that promote ST accumulation (9,40), school PA policies and programs should be boosted by the inclusion of strategies specific to curtailing access to multiple ST devices.

To develop such integrative policies and programs, it is important to evaluate natural experiments (i.e., existing school PA policies and programs) and translate knowledge to school boards and administrators. This study is part of the COMPASS evaluation platform and the findings will be translated to the participating schools across both Canadian provinces as part of the COMPASS's knowledge mobilization protocols (25).

Limitations

Under-reporting, recall bias, and missing data are the primary limitations of the study due to its reliance on self-reported surveys. Nevertheless, COMPASS survey measures have previously demonstrated satisfactory reliability and validity (27). Another limitation of the study is the inability to capture the physical (e.g. home, school), social (e.g. friends, family) and device contexts (e.g. laptop, desktop). One solution would be the utilization of adapted ST surveys that capture the variation in ST behaviours accumulated over different types of screens or devices, and physical contexts. Moreover, with evidence of active youth who have lower ST being associated with active friends (41), ST surveys need to be adapted to capture important social context. Finally, as this study is cross-sectional, the causal inferences cannot be made.

Conclusion

With youth spending a large proportion of their daily time in front of various electronic and digital devices that enable accumulation of multiple ST behaviours, it is necessary to develop strategies to engage them in health promoting activities that reduce their ability to spend long periods of time accessing electronic and digital devices. In developing these strategies, schools can play a critical role through PA policies and

programs, not only because schools are essential contexts for delivering interventions that have long lasting impact, but also because youth who spend more time in various PA pursuits have less time to spend in front of screens. Our study's results show that school PA policies and programs have a positive association with lower ST among youth, after controlling for varying weather patterns across two geographically and climatically distinct provinces, thus highlighting the importance of school PA policies and programs in reducing ST behaviours among youth.

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Table 1. Within-province, between-school differences in total screen time /day based on presence/absence of school PA policies, and utilization of school PA programs

School-level questions	Outcome	Total Screen Time in Minutes					
		AB		P-value	ON		P-value
		Yes	No		Yes	No	
Do the majority of students at your school have regular access to INDOOR physical activity areas during non-instructional school time? *(e.g., during lunch, spare periods)*	Alberta (Yes=10, No=0) Ontario (Yes=52, No=26)	468.6			471.3	488.9	<.0001
Do the majority of students at your school have regular access to OUTDOOR physical activity areas during non-instructional time? *(e.g., during lunch, spare periods)*	Alberta (Yes=10, No=0) Ontario (Yes=67, No=9)	468.6			475.9	492.9	0.0006
Does your school have: Indoor facilities (e.g., dance studio, yoga room, fitness room)	Alberta (Yes=9, No=1) Ontario (Yes=76, No=2)	467.7	480.3	0.5544	479.0	436.9	0.1526

Do students have access to physical activity equipment such as soccer and basketballs during <u>non-instructional times</u> throughout the school day? *(e.g., during lunch, or spare periods)*	Alberta (Always =5, Sometimes =5, Never = 0) Ontario (Always =24, Sometimes =44, Never =10)	463.5 (Always) 474.5 (Sometimes)		0.3274 *	470.0 (Always) 476.8 (Sometimes) 491.6(Never)	<.0001 *
Do the majority of students at your school have <u>regular access</u> to any of the following? **<u>If yes</u>**, are privacy curtains/stalls (**<u>not</u>** including shower or bathroom stalls) available for …BOYS	Alberta (Yes=5, No=3) Ontario (Yes=18, No=51)	474.4	465.6	0.5290	471.9	482.9	0.0026
<u>Outside of school hours</u>, does your school permit <u>regular student access</u> to the following? (Outside of school hours means before school, after school,	Alberta (Yes=8, No=2), Ontario(Yes=64, No=15)	463.6	496.3	0.0359	479.9	473.5	0.1056

evenings and weekends. Student access may occur via school-led, community-led or informal use.) Gymnasium(s)							
Student-level questions							
Are you taking a physical education class at school this year?	Alberta (Yes=2253, No=1275) Ontario(Yes=22266, No=18821)	479.8	450.0	0.011	470.7	485.5	<.0001
Do you participate in before-school, noon hour, or after school physical activities organized by your school? (e.g., intramurals, non-competitive clubs)	Alberta (Yes=1053, No=2484) Ontario(Yes=15559, No=25584)	416.2	491.0	<.0001	438.9	501.6	<.0001
Do you participate in competitive school sports teams that compete against other schools? (e.g., junior varsity or varsity sports)	Alberta (Yes=1125, No=2406) Ontario(Yes=17400, No=23733)	424.5	488.4	<.0001	438.0	507.0	<.0001
Do you participate in league or team	Alberta (Yes=1659, No=1896) Ontario(Yes=20656	440.4	494.5	<.0001	444.1	511.6	<.0001

sports outside of school?	, No=20411)						

P-values are based on Analysis of Variance (ANOVA) and show the differences between within-province total screen time behaviours/day based on the presence/absence of school PA policies, and utilization of school PA programs (Yes/No)

Table 2. Demographic and screen time characteristics for students participating in Y2 of the COMPASS study in Ontario and Alberta, Canada (2013-2014)

Descriptive Category	ONTARIO (N = 41,324)				ALBERTA (N =3,537)			
	Female (n = 20,388)	Male (n = 20,936)	DF	P-value	Female (n = 1,761)	Male (n = 1,776)	DF	P-value
Grade (%; n)								
9	26.7 (5445)	27.5 (5742)	3	0.027	15.0 (264)	15.4 (274)	3	0.6978
10	26.2 (5344)	25.3 (5277)			33.0 (582)	31.3 (556)		
11	24.9 (5062)	24.4 (5099)			28.3 (499)	28.5 (505)		
12	22.2 (4511)	22.9 (4777)			23.6 (416)	24.8 (440)		
Age (%; n)								
13	1.1 (229)	1.2 (250)	5	<.0001	0.4 (7)	0.6 (10)	5	0.0214
14	21.6 (4405)	21.6 (4517)			13.0 (229)	11.5 (204)		
15	25.9 (5284)	24.8 (5176)			29.4 (517)	26.8 (475)		
16	25.3 (5155)	24.5 (5129)			30.2 (531)	29.4 (522)		
17	20.2 (4119)	20.6 (4307)			22.2 (391)	24.8 (440)		
18	5.8 (1179)	7.3 (1528)			4.9 (86)	6.9 (123)		
Ethnicity (%; n)								
1-White	75.3 (15342)	73.2 (15315)	5	<.0001	74.2 (1307)	72.6 (1290)	5	0.0067
2-Black	3.2 (657)	4.9 (1033)			1.2 (21)	2.8 (50)		
3-Asian	5.2 (1068)	5.2 (1082)			3.4 (60)	4.4 (78)		
4-Aboriginal	3.0 (613)	2.8 (591)			11.1 (195)	10.2 (182)		
5-Hispanic	1.9 (386)	2.2 (453)			0.5 (8)	0.2 (4)		
6-Other/Mixed	11.4 (2322)	11.8 (2462)			9.7 (170)	9.7 (172)		
BMI Categories (%; n)								
Underweight	1.4 (282)	1.7 (350)	4	<.0001	1.4 (25)	1.8 (32)	4	<.0001

Healthy weight	61.7 (12574)	52.6 (11021)			58.0 (1022)	50.0 (888)		
Overweight	11.4 (2332)	16.7 (3493)			11.8 (208)	16.9 (300)		
Obese	4.1 (838)	8.3 (1734)			6.0 (105)	10.1 (180)		
Not Stated	21.4 (4362)	20.7 (4338)			22.8 (401)	21.2 (376)		
Physical Activity (Mean minutes/day; SD)								
Moderate to Vigorous physical Activity	108.1(78.4)	138.4(95.6)		<.0001	107.6(77.8)	147.1(101.9)		<.0001
Multiple Screen time behaviours (Mean minutes/day; SD)								
Total Screen time	473.7(318.7)	481.5(332.0)		0.0153	459.9(325.0)	476.9(340.5)		0.1295
TV	122.6(92.1)	120.4(96.0)		0.0147	115.3(89.1)	119.4(98.1)		0.1945
Internet Surfing	143.0(129.7)	117.3(120.7)		<.0001	128.6(133.8)	104.8(118.5)		<.0001
Video Games	38.4(81.4)	126.0(128.4)		<.0001	43.7(83.8)	125.4(127.0)		<.0001
Communication-based screen time behaviours	169.7(165.3)	117.9(145.3)		<.0001	172.2(169.2)	127.2(154.7)		<.0001

Table 3. Random-intercept linear regression models showing the relationship between school physical activity policies and programs with multiple and total screen time behaviours among boys in 79 Ontario schools

	TV N=14,707	Video N=12,740	Surf N=14,188	Text N=13,658	Total Screen N=15,826
Do you participate in before-school, noon hour, or after school physical activities organized by your school? (e.g., intramurals, non-competitive clubs)					
YES vs. NO	-0.01 (-0.05, 0.03)	**-0.16 (-0.21, -0.11)***	-0.04 (-0.09, 0.01)	-0.05 (-0.11, 0.01)	**-0.13 (-0.18, -0.07)***
Do you participate in league or team sports outside of school?					
YES vs. NO	**-0.06 (-0.10, -0.02)****	**-0.21 (-0.26, -0.15)***	**-0.26 (-0.31, -0.22)***	**0.07 (0.01, 0.13)*****	**-0.15 (-0.21, -0.10)***
Do you participate in competitive school sports teams that compete against other schools? (e.g., junior varsity or varsity sports)					
YES vs. NO	-0.01 (-0.06, 0.03)	**-0.18 (-0.23, -0.12)***	**-0.12 (-0.17, -0.07)***	0.00 (-0.06, 0.07), 0.9153	**-0.13 (-0.18, -0.07)***
Built and environment					
All amusement & recreation	0.00 (-0.01, 0.00)	0.00 (-0.01, 0.01)	0.00 (-0.01, 0.00)	0.00 (-0.01, 0.01)	0.00 (-0.01, 0.01)
Amusement parks	-0.02 (-0.08, 0.03)	**0.09 (0.02, 0.16)****	0.00 (-0.06, 0.07)	0.00 (-0.09, 0.10)	0.07 (-0.03, 0.16)
Museum	0.00 (-0.02, 0.02)	0.01 (-0.02, 0.04)	0.00 (-0.03, 0.02)	0.01 (-0.03, 0.04)	0.02 (-0.02, 0.06)
Open Areas	0.00 (0.00, 0.00)	0.00 (0.00, 0.00)	0.00 (0.00, 0.00)	0.00 (-0.01, 0.00)	0.00 (0.00, 0.00)
Parks	-0.01 (-0.01, 0.00)	0.00 (-0.01, 0.01)	-0.01 (-0.02, 0.00)	0.00 (-0.02, 0.01)	-0.01 (-0.03, 0.00)
Do the majority of students at your school have regular access to INDOOR physical activity areas during non-instructional school time? (e.g., during lunch, spare periods)					
YES vs. NO	-0.02 (-0.08, 0.04)	**-0.10 (-0.18, -0.02)****	-0.01 (-0.08, 0.06)	-0.02 (-0.13, 0.08)	-0.06 (-0.17, 0.05)
Do the majority of students at your school have regular access to OUTDOOR physical activity areas during non-instructional time? (e.g., during lunch, spare periods)					
YES vs. NO	**-0.08 (-0.16, -0.01)*****	0.01 (-0.09, 0.11)	0.01 (-0.08, 0.09)	0.03 (-0.11, 0.16)	-0.04 (-0.17, 0.10)
Weather					
Daylig	0.02 (0.00,	-0.01 (-0.04,	0.01 (-0.02,	0.01 (-0.03,	-0.01 (-0.05,

ht hours	0.04)	0.02)	0.03)	0.05)	0.03)
Maximum temperature	**-0.01 (-0.01, 0.00)****	-0.01 (-0.01, 0.00)	**-0.01 (-0.01, 0.00)*****	**-0.01 (-0.02, 0.00)*****	**-0.01 (-0.02, 0.00)*****
Precipitation	0.01 (0.00, 0.02)	**0.02 (0.00, 0.03)****	-0.01 (-0.02, 0.01)	0.00 (-0.02, 0.03)	0.0 -0.02, 0.03)

Note: *p<.0001, **p<0.01, ***p<0.05. Models were adjusted for age, sex, ethnicity. Cubic root transformation was applied to all outcomes. Outliers were removed after model validation.

Table 4. Random-intercept linear regression models showing the relationship between school physical activity policies and programs with multiple and total screen time behaviours among girls in 79 Ontario schools

	TV N=14,527	Video N=5,685	Surf N=14,209	Text N=14,451	Total Screen N=15,476
Do you participate in before-school, noon hour, or after school physical activities organized by your school? (e.g., intramurals, non-competitive clubs)					
YES vs NO	**-0.07 (-0.11, -0.02)****	0.00 (-0.08, 0.08)	-0.04 (-0.10, 0.01)	-0.05 (-0.12, 0.01)	**-0.09 (-0.15, -0.03)****
Do you participate in league or team sports outside of school?					
YES vs NO	**-0.11 (-0.15, -0.07)***	**-0.15 (-0.22, -0.08)***	**-0.15 (-0.21, -0.10)***	-0.02 (-0.08, 0.05)	**-0.17 (-0.22, -0.11)***
Built and environment					
All amuse and recreation	0.00 (-0.01, 0.00)	0.00 (-0.01, 0.01)	0.00 (-0.01, 0.01)	0.00 (-0.01, 0.00)	**-0.01 (-0.02, 0.00)*****
Amusement parks	**0.07 (0.02, 0.12)****	0.08 (0.00, 0.17)	0.01 (-0.05, 0.07)	**0.09 (0.01, 0.16)*****	**0.11 (0.04, 0.18)****
Museum	0.02 (0.00, 0.04)	0.00 (-0.04, 0.03)	0.00 (-0.02, 0.03)	0.01 (-0.02, 0.04)	0.02 (-0.01, 0.05)
Parks	0.00 (-0.01, 0.01)	0.00 (-0.01, 0.01)	0.00 (-0.01, 0.00)	**-0.01 (-0.02, 0.00)****	-0.01 (-0.02, 0.00)
Physical fitness facilities	0.01 (-0.01, 0.03)	0.00 (-0.03, 0.03)	0.01 (-0.02, 0.03)	0.00 (-0.02, 0.03)	0.02 (0.00, 0.05)
Sporting goods & bicycle shops	-0.01 (-0.02, 0.01)	-0.01 (-0.03, 0.02)	0.01 (-0.01, 0.02)	**0.03 (0.01, 0.05)****	0.01 (0.00, 0.03)
Do the majority of students at your school have regular access to INDOOR physical activity areas during non-instructional school time? (e.g., during lunch, spare periods)					
YES vs NO	0.01 (-0.05, 0.06)	-0.07 (-0.17, 0.03)	**-0.11 (-0.18, -0.04)****	0.00 (-0.08, 0.09)	**-0.09 (-0.17, -0.01)*****
Do the majority of students at your school have regular access to OUTDOOR physical activity areas during non-instructional time? (e.g., during lunch, spare periods)					
YES vs NO	-0.07 (-0.14, 0.00)	-0.01 (-0.13, 0.10)	0.00 (-0.08, 0.09)	**-0.18 (-0.28, -0.08)****	**-0.11 (-0.21, -0.02)*****
Weather					
Daylight hours	-0.01 (-	-0.02 (-	**0.03 (0.00,**	**-0.06 (-**	-0.02 (-0.05,

	0.03, 0.02)	0.05, 0.02)	**0.05)*** **	**0.09, -0.03)***	0.01)
Maximum temperature	**-0.01 (-0.01, -0.01)***	0.00 (-0.01, 0.01)	**-0.01 (-0.01, 0.00)****	0.00 (0.00, 0.01)	**-0.01 (-0.02, 0.00)****
Precipitation	0.00 (-0.01, 0.01)	-0.01 (-0.02, 0.01)	0.00 (-0.02, 0.01)	0.00 (-0.02, 0.02)	0.00 (-0.02, 0.01)

Note: *p<.0001, **p<0.01, ***p<0.05. Models were adjusted for age, sex, ethnicity. Cubic root transformation was applied to all outcomes. Outliers were removed after model validation.

Table 5. Random-intercept linear regression models showing the relationship between school physical activity policies and programs with multiple and total screen time behaviours among all youth in 10 Alberta schools

	TV N=2,477	Video N=1,586	Surf N=2,292	Text N=2,353	Total Screen N=2,649
Do you participate in before-school, noon hour, or after school physical activities organized by your school? (e.g., intramurals, non-competitive clubs)					
YES vs NO	**-0.11 (-0.22, 0.00)*** **	-0.16 (-0.32, 0.01)	-0.08 (-0.23, 0.06)	-0.12 (-0.30, 0.05)	**-0.21 (-0.37, -0.06)** **
Do you participate in competitive school sports teams that compete against other schools? (e.g., junior varsity or varsity sports)					
YES vs NO	-0.08 (-0.19, 0.03)	-0.11 (-0.28, 0.05)	**-0.15 (-0.29, -0.01)*** **	0.04 (-0.13, 0.22)	-0.15 (-0.31, 0.01)
Does your school offer non-competitive sports clubs (e.g. rock climbing, dance, outdoor club) that involve physical activity?					
YES vs NO	-0.03 (-0.13, 0.07)	-0.08 (-0.23, 0.07)	-0.12 (-0.25, 0.01)	-0.08 (-0.24, 0.09)	-0.13 (-0.33, 0.06)
Weather					
Daylight hours	0.04 (0.00, 0.07)	0.02 (-0.03, 0.08)	0.01 (-0.04, 0.05)	0.03 (-0.03, 0.09)	0.03 (-0.02, 0.9)
Maximum temperature	0.00 (-0.01, 0.01)	-0.01 (-0.02, 0.00)	-0.01 (-0.02, 0.00)	0.00 (-0.02, 0.01)	0.00 (-0.02, 0.01)
Precipitation	0.00 (-0.06, 0.06)	0.07 (-0.02, 0.16)	**-0.08 (-0.16, -0.01)*** **	-0.03 (-0.12, 0.07)	-0.04 (-0.12, 0.07)

Note: *p<.0001, **p<0.01, ***p<0.05. Models were adjusted for age, sex, ethnicity. Cubic root transformation was applied to all outcomes. Outliers were removed after model validation.

Figure 1. Distribution of the proportion of Ontario youth (total, girls, boys) based on average screen time per day (sum of all types of screen time) in the COMPASS study (2013-2014)

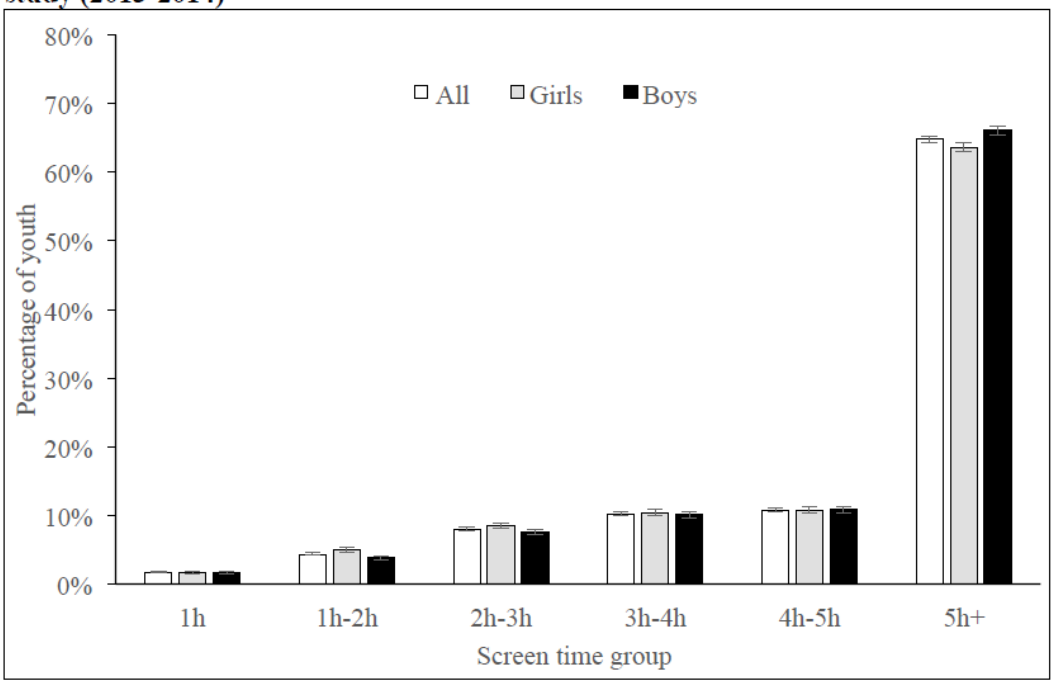


Figure 2 Distribution of the proportion of Alberta youth (total, girls, boys) based on average screen time per day (sum of all types of screen time) in the COMPASS Study (2013-2014)

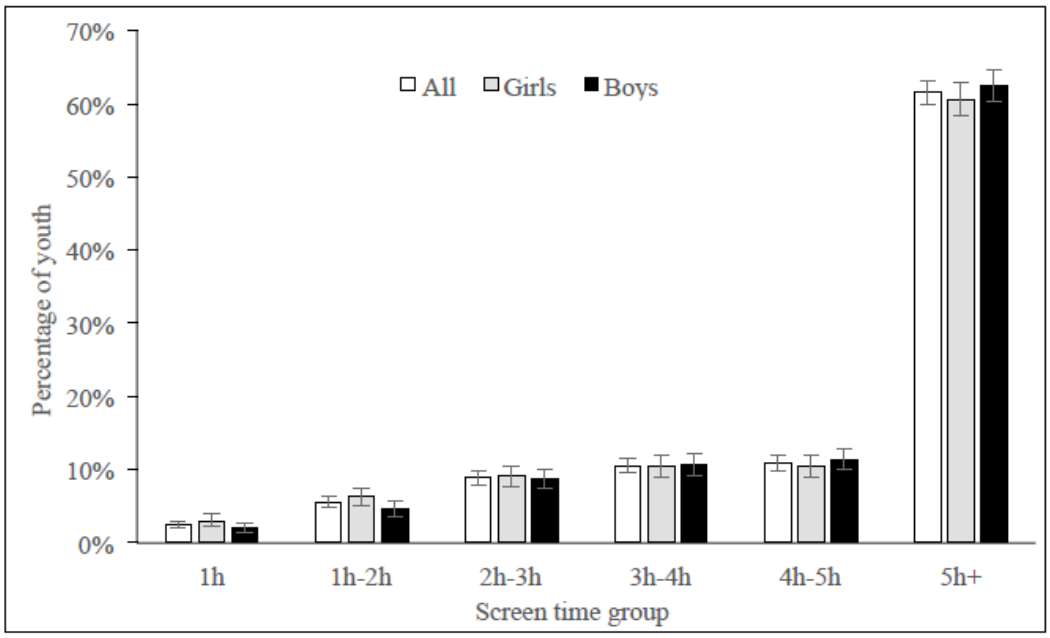


Figure 3 Average time spent in moderate-to-vigorous physical activity per day across the average screen time among youth in Ontario, Canada participating in the COMPASS Study (2013-2014)

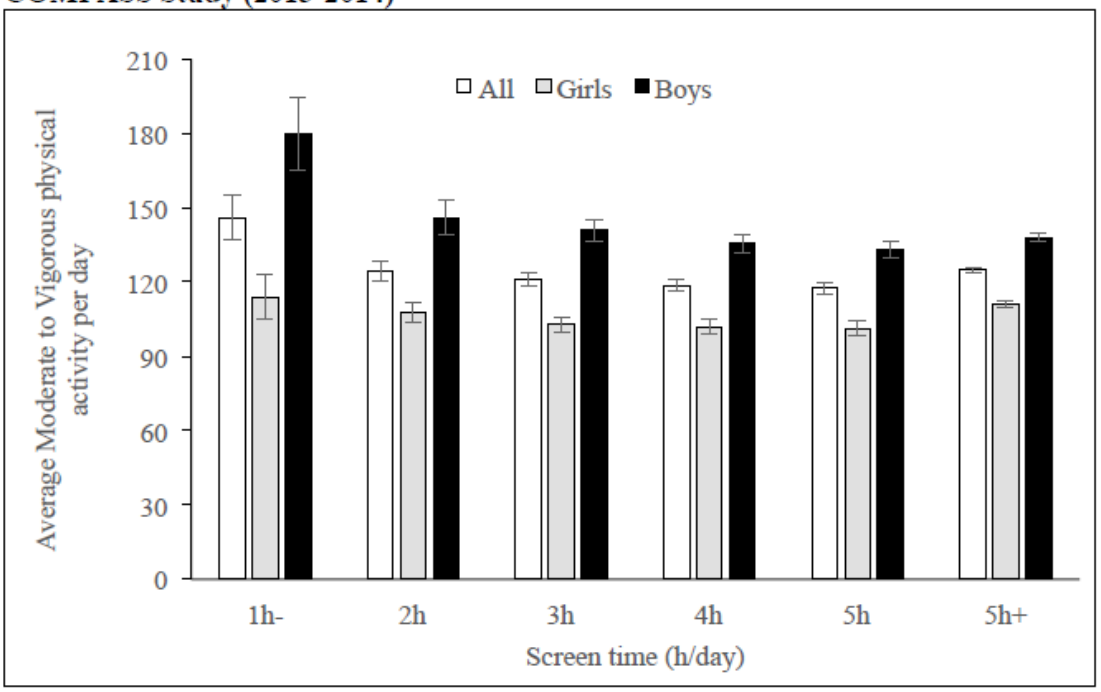
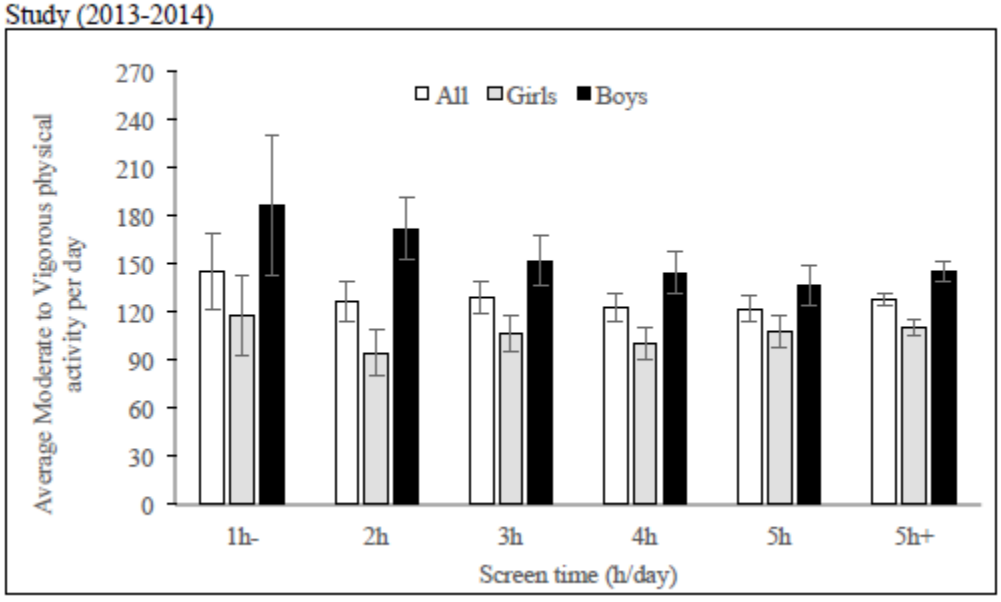


Figure 4 Average time spent in moderate-to-vigorous physical activity per day across the average screen time among youth in Alberta, Canada participating in the COMPASS Study (2013-2014)



HIGHLIGHTS

- Schools are critical places to implement policies promoting physical activity
- School physical activity policies can reduce total screen time among youth
- Physical activity participation reduces the time available for screen time behaviours
- Access to indoor physical activity areas is associated with lower screen time
- Intramural physical activity programs are associated with lower screen time