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High School Intramural Participation and Substance Use: A Longitudinal Analysis of COMPASS Data

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ABSTRACT

Background: There is an association between sports participation and substance use. However, there is some evidence that intramural sports in high school may not have the same effect. Therefore, the objective of this research was to examine the longitudinal associations between intramural participation in high school and substance use. **Methods:** This study used a three-year linked sample (2016-2018) of grade 9 and 10 (ages 13-17) Canadian high school students in the COMPASS (Cannabis use, Obesity, Mental health, Physical activity, Alcohol use, Smoking, Sedentary behavior) study ($n=7,845$). Students reported their participation in intramurals over time (consistent, none, initiate, intermittent, and quit) and their substance use behaviors (binge drinking, cannabis use, cigarette use, and e-cigarette use). Mixed effects models were used. **Results:** 42% of students did not participate in intramurals. For binge drinking, male students who never participated had lower odds (0.66 [0.47-0.93]) compared to consistent intramural participants. Female (3.50 [CI: 1.34-9.16]) and male students (1.97 [1.28-3.02]) who did not participate in any intramurals were more likely to use cannabis than consistent participants. Male students who did not participate were also more likely to use cigarettes (1.81 [1.05-3.12]). No associations were found between intramural participation and e-cigarette use. **Conclusion:** Intramural participation may be associated with increased binge drinking among male high school students. More promisingly, consistent participation in intramurals may be protective against cannabis use among male and female students and cigarette use among male students.

KEYWORDS



adolescent; physical activity; sports; binge drinking; cannabis; cigarettes; vaping


Introduction

Physical activity has a multitude of health benefits for youth including healthy development, disease prevention and improved mental health (2018 Physical Activity Guidelines Advisory Committee, 2018; Janssen & Leblanc, 2010). To accrue the many benefits of physical activity, it is recommended that Canadian youth aged 5-17 achieve 60 min of moderate-to-vigorous physical activity per day (Canadian Society for Exercise Physiology, 2017). Despite the many benefits, Canadian youth are not meeting the recommended 60 min of daily physical activity (Colley et al., 2017; Janssen et al., 2017; Roberts et al., 2017). In addition to not meeting the physical activity guidelines, a reduction in physical activity has been observed with increasing age in youth (Contardo Ayala et al., 2018; Harding et al., 2015). Therefore, strategies to increase youth physical activity are necessary (Barnes et al., 2018).

School-based physical activity programming is an effective approach to increasing youth physical activity (Lister-Sharp et al., 1999; Timperio et al., 2004; U. S. Department of Health & Human Services, 2012), and school

sports are examples of such effective school-based programming. More specifically, participation in varsity and intramural sports are positively associated with physical activity (Fuller et al., 2011; Hebert et al., 2015; Hobin et al., 2013; Kurc & Leatherdale, 2009; Sallis et al., 2000). Unfortunately, in addition to the positive association between school sport participation and physical activity, there is also an association between school sports participation and substance use among secondary school students (Boyes et al., 2017; Denault & Poulin, 2018; Lisha & Sussman, 2010; Terry-McElrath et al., 2011). For example, team sports participation has consistently been associated with an increased risk of alcohol use (Boyes et al., 2017; Denault & Poulin, 2018; Veliz, Schulenberg, Kloska, McCabe, & Zarrett, 2017). The potential mechanisms behind this association may be explained by individual mental health factors such as coping with pain from sports injuries and coping with stress from high expectations in sport (National Institute on Drug Abuse, 2015; Reardon & Creado, 2014), or the perceived norms of substance use behaviors of coaches and other teammates (Connor et al., 2007; Ford, 2007). This is concerning, as school sports are often encouraged among youth

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to increase physical activity levels, and therefore sport participation may have unintended consequences on youth substance use behaviors (Boyes et al., 2017; Denault & Poulin, 2018; Lisha & Sussman, 2010; Terry-McElrath et al., 2011).

However, varsity and intramural sports may not have the same effect on youth substance use behaviors. Varsity sports refer to competitive school sports teams that compete against other schools where there is typically a try-out process. In contrast, intramurals refer to sports participation within one school that may include all students and no try-out process is required. While varsity programming is often only available to students with a higher level of athletic ability and the ability to pay any team fees, intramural programming typically serves the entire student population and makes participating in recreation more accessible (Edwards et al., 2014). For example, while varsity sports participation has been associated with an increased risk of binge drinking, intramural sports do not have this same positive association (Williams et al., 2020). In fact, among female youth, intramural participation has been associated with lower e-cigarette use whereas participation in varsity sports has been associated with increased e-cigarette use (Williams et al., 2020). However, this protective effect was observed using cross-sectional data, and therefore no temporal conclusions between intramural participation and substance use can be made (Williams et al., 2020). There is currently a lack of longitudinal research in this area. By extending the analysis beyond a single point in time, longitudinal research is a more powerful approach to detecting change over time allowing for the examination of the directionality of the relationship between sport participation and substance use among Canadian youth (Fitzmaurice et al., 2011).

The objective of this study was to examine the longitudinal associations between intramural participation patterns throughout high school and the odds of binge drinking, cannabis use, cigarette use, and e-cigarette use, stratified by sex, in a three-year linked sample (2016-2018) of Canadian high school students in the COMPASS (Cannabis use, Obesity, Mental health, Physical activity, Alcohol use, Smoking, Sedentary behavior) study.

Materials and methods

Procedure

The COMPASS study is an ongoing prospective cohort study that collects data from a large convenience sample of students in grades 9-12 in British Columbia, Alberta, Ontario, and Quebec (grades 7 to 11 only in Quebec). The COMPASS study was designed to evaluate changes in school programs and policies over time. The current study used three years of COMPASS data from Year 5 (Y5: 2016-2017), Year 6 (Y6: 2017-2018), and Year 7 (Y7: 2018-2019). A full description of the COMPASS study can be found in print (Leatherdale et al., 2014) or online (www.compass.uwaterloo.ca). All procedures were approved by the University of Waterloo Office of Research Ethics (reference number 30118) and appropriate school board committees.

Participants

To explore longitudinal changes, Y5 to Y7 student level data within schools were linked. Students are linked anonymously over time using a self-generated identification code. Further details on the data linkage process are described elsewhere (Battista et al., 2019; Qian et al., 2015). Due to the rolling sample design where new grade 9 students enroll in the cohort annually and graduating grade 12 students (grade 11 in Quebec) leave the cohort, it was not possible to link students who were in grade 11 or 12 in Y5 or grade 9 students who were newly admitted in Y6 or Y7. In Y5, 26,859 students in grades 9, 10, and “other” participated in the COMPASS study. “Other” included students from Quebec who were in Secondary 1 or 2 (grade 7-8 equivalent) or a specialized program at baseline. Ages ranged from 13-17 at baseline. 8,859 participants were successfully linked for all 3 years. Participants were required to have complete data for all 3 years to be included in the analysis. Those with missing data were removed, for a final sample size of 7,845. A comparison of the linked and unlinked students can be found in [Supplementary Table 1](#). Demographic characteristics of participants with complete data ($n=7,845$) are compared to those missing only outcome data ($n=190$) in [Supplementary Table 2](#).

Instrumentation

School level data

Schools' *urbanicity* was determined by using Geosearch lookup on city name based on 2016 census data (Statistics Canada, 2016b). Urban/rural classifications were as follows: large urban (populations from 100,000 and greater, with a population density of at least 400 per square kilometre), medium urban (populations between 30,000 and 99,999, with a population density of at least 400 per square kilometre), small urban (populations between 1,000 and 29,000, with a population density of at least 400 per square kilometre), and rural (population less than 1,000 or population density less than 400 per square kilometre). *School neighborhood median household income* was determined using school postal code forward sortation area to identify household median income for an area (Statistics Canada, 2016a). School median income was categorized into 4 groups: less than \$50,000, \$50,001-\$75,000, \$75,001-\$100,000, and greater than \$100,000.

Student level data

During these data collection waves, the COMPASS student questionnaire was administered by teachers in the classroom (Thompson-Haile & Leatherdale, 2013). Teachers were provided with detailed instructions on administering the survey to ensure consistency and student confidentiality (Thompson-Haile & Leatherdale, 2013). All students in participating grades who were present during the survey period, who consented to completing the survey, and whose parents had not refused consent completed the questionnaire during the designated class time. Students were given an envelope

Table 1. Baseline (Year 5, 2016-2017) sample characteristics in the three-year linked sample of Canadian high school students in the COMPASS study by sex ($n=7,845$).

Variable		Total		Female ($n=4,388$)		Male ($n=3,457$)		Chi square / T-test		
		Freq	%	Freq	%	Freq	%	df	Value	P-value
Grade	9	3945	50.3	2212	50.4	1733	50.1	2	7.0887	0.0289
	10	2662	33.9	1447	33.0	1215	35.2			
	Other	1238	15.8	729	16.6	509	14.7			
Ethnicity	White	5881	75.0	3300	75.2	2581	74.7	1	0.3060	0.5801
	Other	1964	25.0	1088	24.8	876	25.3			
Weekly spending money	Zero	1607	20.5	771	17.6	836	24.2	4	78.8089	<.0001
	\$1-\$20	2872	36.6	1653	37.7	1219	35.3			
	\$21-\$100	1571	20.0	916	20.9	655	19.0			
	\$100+	474	6.0	229	5.2	245	7.1			
	Don't Know	1321	16.8	819	18.7	502	14.5			
Binge drinking	No	7319	93.3	4088	93.2	3231	93.5	1	0.2770	0.5987
	Yes	526	6.7	300	6.8	226	6.5			
Cannabis use	No	7537	96.1	4220	96.2	3317	96.0	1	0.2507	0.6166
	Yes	308	3.9	168	3.8	140	4.0			
Cigarette smoking	No	7633	97.3	4276	97.5	3357	97.1	1	0.8515	0.3561
	Yes	212	2.7	112	2.5	100	2.9			
E-cigarette use	No	7342	93.6	4184	95.4	3158	91.4	1	51.5600	<.0001
	Yes	503	6.4	204	4.7	299	8.7			
Intramural participation pattern over time	Consistent	1279	16.3	634	14.5	645	18.7	4	38.0934	<.0001
	None	3268	41.7	1895	43.2	1373	39.7			
	Initiate	1001	12.8	522	11.9	479	13.9			
	Intermittent	905	11.5	516	11.8	389	11.3			
	Quit	1392	17.7	821	18.7	571	16.5			
Varsity participation	No (Ref)	4699	59.9	2757	62.8	1942	56.2	1	35.6480	<.0001
	Yes	3146	40.1	1631	37.2	1515	43.8			
School connectedness (Mean, SD)		19.1	2.9	19.0	2.9	19.1	2.8	7843	-1.93	0.0541

Table 2. ICC values for substance use over time from Year 5 (2016-2017) to Year 7 (2018-2019) of the COMPASS study in Canada.

Substance	Female ICC	Male ICC
Binge drinking	60.2%	57.8%
Cannabis use	67.5%	63.4%
Cigarette use	94.9%	94.2%
E-cigarette use	44.9%	52.8%

in which to seal their questionnaire upon completion. A COMPASS data collector was available throughout the survey completion to oversee data collection and to return the surveys to the University of Waterloo for processing.

To assess *intramural participation patterns over time*, students were asked “Do you participate in before-school, noon hour, or after-school physical activities organized by your school? (e.g. intramurals, non-competitive clubs). Students were classified based on their responses to this question over time.” Students were labeled “consistent” participants if they participated in intramurals for all three years of the study. Students who reported no intramural participation from Y5 to Y7 were labeled as “None.” Students were labeled as “initiate” if they began participating in intramurals in Y6 or Y7. Students who “Quit” reported intramural participation in Y5 and then quit in either Y6 or Y7. Students who did not fit any of these categories were labeled “Intermittent” participants.

Substance use was measured in all three years of the study. Substance use measures are consistent with the Health Canada recommended youth substance use surveillance measures from the Canadian Student Tobacco, Alcohol and Drug

Use Survey (CSTADS) (Bredin & Leatherdale, 2014; Elton-Marshall et al., 2011). While the psychometrics properties of the alcohol and cannabis use measures are not available (Bredin & Leatherdale, 2014), measures of cigarette use produce accurate estimates of cigarette smoking among Canadian youth (Wong et al., 2012).

To assess *binge drinking*, students were asked “In the last 12 months, how often did you have 5 drinks of alcohol or more on one occasion?” This question was grouped into a binary variable indicating whether the student engaged in binge drinking at least once a month or not. *Cannabis use* was determined by asking “In the last 12 months, how often did you use marijuana or cannabis (a joint, pot, weed, hash)?” This question was grouped into a binary variable indicating whether the student engaged in cannabis use at least once a month or not. To assess *cigarette use* students were asked “On how many of the last 30 days did you smoke one or more cigarettes?” Students were grouped based on if they reported past 30-day use or not. *E-cigarette use* was determined by the question “On how many of the last 30 days did you use an e-cigarette?” Students were grouped based on if they reported past 30-day use or not.

Varsity sport participation was measured each year by asking students “Do you participate in competitive school sports teams that compete against other schools? (e.g. junior varsity or varsity sports).” Response options were “Yes, No, or None available.” Students who indicated “None available,” and “No” were grouped together.

School connectedness was measured using a six-item derived scale based on students’ level of agreement with

the questions: “I feel close to people at my school”, “I feel I am a part of my school”, “I am happy to be at my school”, “I feel the teachers at my school treat me fairly”, “I feel safe in my school” and “Getting good grades is important to me”. The school connectedness score ranges from 6 to 24, with higher scores indicating greater school connectedness and was measured for all three years of the study. School connectedness had an alpha reliability of 0.80.

Consistent with national youth health surveillance research (Elton-Marshall et al., 2011), the following demographic covariates measured at baseline were included in analyses: Grade, (9,10,other), sex (female, male), ethnicity (white, other), weekly spending money (Zero, \$1 to \$20, \$21 to \$100, More than \$100, Don't know). Student weekly spending money categories were created to be consistent with national youth health surveillance research (Elton-Marshall et al., 2011) and have been used extensively in other studies using COMPASS data (Butler et al., 2019; Godin et al., 2018; Milicic et al., 2018; Zuckermann et al., 2020).

Data analysis

All analyses were performed in SAS 9.4 (SAS Institute, Cary, NC). Descriptive characteristics at the student level ($n=7,845$) were calculated and Chi-square was used to examine differences between male and female students in the sample at baseline.

Mixed effects logistic regression models were used *via* the mixed procedure (PROC MIXED) to model whether intramural participation patterns over time predicted the following binary outcomes: binge drinking (Model 1), cannabis use (Model 2), cigarette use (Model 3), and e-cigarette use (Model 4) in each year. Due to previously identified differences, all models were stratified by sex (Boyes et al., 2017; Williams et al., 2020). All models included intramural participation pattern and year (time variable). For models where a significant main effect was seen, an interaction with year was tested. Interaction results were presented only if this interaction was found to be significant. Models controlled for grade, ethnicity, spending money, other substance use, province, school neighborhood median income, and urbanicity at baseline and school connectedness and varsity participation at each time point. All mixed effects models included a random intercept term to account for the within-student correlation of response over time. Additional null models with no predictors were run to calculate the intraclass correlation coefficient (ICC), which quantifies the magnitude of within- vs. between-student variability in outcomes.

Results

Descriptive statistics

Baseline characteristics are presented in Table 1. Over half of the sample was female (56%) and identified as white

(75%). At baseline, half of students were in grade 9 (50%) and few reported binge drinking (7%), cannabis use (4%), cigarette smoking (3%), or e-cigarette use (6%). Over time, 42% of students did not participate in any intramurals, 13% initiated intramural participation in Y6 or Y7, 12% participated intermittently, 18% quit in either Y6 or Y7, and 16% reported consistent intramural participation throughout high school.

Figure 1 presents substance use and intramural participation over time. All substance use increased significantly from Y5 to Y7 ($p<.0001$). By Y7, 20% of female and 24% of male students reported binge drinking, 13% and 18% reported cannabis use, 6% and 8% reported cigarette use, and 29% and 36% reported e-cigarette use, respectively. Overall, intramural participation declined significantly over time among female students from 38% in Y5 to 31% in Y7 ($<.0001$) and male students from 40% to 37% ($p=0.0232$).

Regression models

Table 2 presents ICC values for female and male students' substance use over time. ICC indicates the percent of the variability in an outcome that is due to variability between students. ICC values ranged from 45% to 95%. Meaningful between-student variability was seen across all outcomes. For example, 60% of the variability in binge drinking among female students was due to between-student differences while the remaining 40% was due to within student variability over time. ICC values for cigarette use were particularly high: 95% for females and 94% for males.

Table 3 presents regression results for female students. Overall, the odds of binge drinking, cannabis use, and e-cigarette use increased significantly from Y5 to Y7. While significant baseline differences in odds of substance use were identified between some groups, there was no significant interaction with time for binge drinking, cigarette use, or e-cigarette use, indicating no variability in odds of use over time between groups, so models with only main effects are shown in Table 3. For binge drinking (Table 3, Model 1), no significant effect was found for intramural participation. In contrast, a significant interaction between time and intramural participation pattern was found for cannabis use (Table 3, Model 2). Compared to consistent intramural participation, quitting intramural participation was associated with increased odds of cannabis use overall among females at baseline (OR 4.41 [95% CI 1.60-12.16]). Additionally, a significant inverse interaction with time indicated that these students increased their cannabis use at a slower rate than consistent participators, however, they still had higher odds of cannabis use overall due to increased baseline odds. Figure 2 compares the odds of cannabis use by intramural participation pattern to illustrate this interaction effect. None (OR 3.50 [95%CI: 1.34-9.16]), initiate (OR 3.13 [95% CI: 1.03-9.52]), and intermittent (OR 3.08 [95% CI: 1.01-9.43]) patterns of intramural participation were also associated with increased baseline odds of cannabis use among females but no significant interaction over time was found. For cigarette use, female students who quit intramurals (OR 1.93

[95% CI: 1.09-3.41]) were more likely to use cigarettes than consistent participants at baseline. No significant associations with intramural participation were seen for e-cigarette use among females (Model 4).

Table 4 presents regression results for male students. No significant interactions were found between time and intramural participation pattern in any model among males, suggesting no differential impact on substance use patterns over time. Overall, time was associated with increasing binge drinking, cannabis use, and e-cigarette use. For binge drinking (Model 1), none (OR 0.66 [95% CI: 0.47-0.93]) was associated with decreased odds of binge drinking compared to consistent participation among males. None (OR 1.97 [95% CI: 1.28-3.02]) and intermittent (OR 1.85 [95% CI: 1.14-3.00]) intramural participation were associated with increased odds of cannabis use compared to consistent participants. None (OR 1.81 [95% CI: 1.05-3.12]) and quit

(OR 1.97 [95% CI: 1.12-3.45]) intramural participation were associated with increased odds of cigarette use compared to consistent participants. Finally, no significant associations with intramural participation were seen for e-cigarette use among males (Model 4).

Discussion

While it was encouraging to identify that a majority of students participated in intramurals in at least one year of our study, it was discouraging but not surprising to also identify that intramural participation decreased over time and all forms of substance use increased. This is consistent with existing literature that shows older students are less likely to participate in sports (Telford et al., 2016; van Mechelen et al., 2000) and more likely to engage in

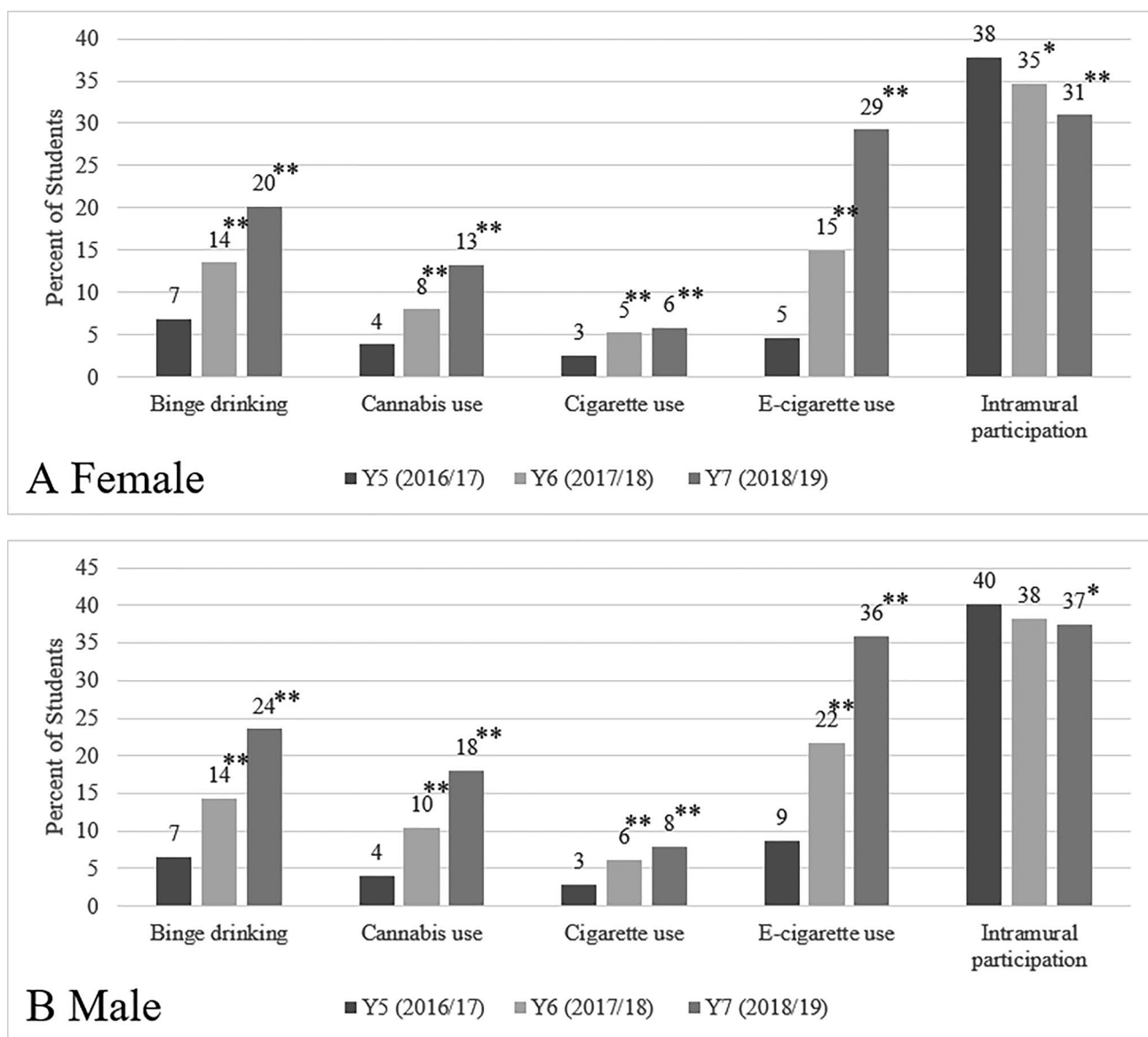


Figure 1. Substance use and intramural participation over time (Y5-Y7) among the three-year linked sample of female (A) and male (B) Canadian high school students in the COMPASS study ($n=7,845$).

* represents a $p < 0.05$ significant difference from Y5; ** represents a $p < 0.0001$ significant difference from Y5

Table 3. Mixed effects logistic regression results between intramural participation pattern over time and odds of substance use over time among females in Y5 (2016-2017) to Y7 (2018-2019) of the COMPASS study in Canada ($n=4,388$).

Variable	Model 1 Binge drinking OR (95% CI)	Model 2 Cannabis use OR (95% CI)	Model 3 Cigarette use OR (95% CI)	Model 4 E-cigarette use OR (95% CI)
Time				
Y5 (Ref)	-	-	-	-
Y6	1.82 (1.50-2.20)	1.90 (0.71-5.12)	1.29 (0.94-1.77)	5.01 (4.01-6.28)
Y7	2.52 (2.06-3.07)	5.23 (2.07-13.25)	0.65 (0.46-0.91)	18.14 (14.22-23.14)
Intramural participation pattern				
Consistent (Ref)	-	-	-	-
None	1.10 (0.79-1.52)	3.50 (1.34-9.16)	1.54 (0.88-2.71)	1.09 (0.79-1.50)
Initiate	1.42 (0.99-2.04)	3.13 (1.03-9.52)	0.95 (0.49-1.84)	0.90 (0.63-1.30)
Intermittent	1.30 (0.90-1.88)	3.08 (1.01-9.43)	1.02 (0.53-1.96)	0.95 (0.66-1.37)
Quit	1.22 (0.88-1.70)	4.41 (1.60-12.16)	1.93 (1.09-3.41)	1.36 (0.98-1.88)
Interactions				
None*Y6		1.35 (0.47-3.88)		
None*Y7		0.66 (0.24-1.77)		
Initiate*Y6		0.85 (0.24-2.98)		
Initiate*Y7		0.63 (0.19-2.06)		
Intermittent*Y6		0.56 (0.16-2.05)		
Intermittent*Y7		0.38 (0.11-1.25)		
Quit*Y6		0.39 (0.12-1.26)		
Quit*Y7		0.33 (0.11-.098)		

OR=Odds Ratio; CI=Confidence Interval; The odds ratios represent the multiplicative increase in odds of use in the stated category compared to the reference category. Results controlled for grade, ethnicity, spending money, other substance use, school connectedness, varsity participation, province, school neighborhood median income, and urbanicity.

substance use (Montreuil et al., 2017; Romano et al., 2019; Windle, 2016). Considering only 16% of students in our sample consistently participated in intramurals, and consistent intramural participation appears to have provided some protective impact on reducing the odds of cigarette and cannabis use, this suggests that efforts to promote ongoing intramural participation in schools may be a school-based substance use prevention strategy that warrants additional investigation. Along with potentially providing some protection against substance use, ongoing intramural participation offers potential health benefits associated with increased activity (e.g. fitness and mental health) (Biddle et al., 2019; Janssen & Leblanc, 2010), and can be considered an equitable approach to participation in sports.

Male students who did not participate in intramurals were less likely to binge drink than their consistently participating counterparts. These associations did not change over time. These findings are in line with other research that has consistently linked sports participation to increases in binge drinking and alcohol use over time (Denault & Poulin, 2018; Lau et al., 2019; Modecki et al., 2014). Our study adds to these findings by highlighting the association with binge drinking among less competitive sports such as intramurals. This may be due to the ubiquitous presence of alcohol marketing in team sports, both within sporting venues and on television. Studies have consistently linked exposure to alcohol marketing and adolescent alcohol use (Anderson et al., 2009; Morojelo et al., 2018) and one systematic review has specifically linked alcohol sports sponsorship to alcohol consumption among young people (Brown, 2016). Due to the association between sports and alcohol consumption, intramurals may be a potential avenue to reach adolescent males and promote safer drinking behaviors.

No participation in intramurals and intermittent participation were associated with increased odds of cannabis use compared to consistent participators among male students. There was also evidence of increased baseline risk of cannabis use among female students with some significant differences over time. All categories of intramural participation (none, initiate, intermittent, and quit) were associated with higher odds of cannabis use at each time point compared to consistent participators, although the quit group showed significantly different patterns in use consumption over time, corresponding to a slower rate of increase in odds of use after two years compared to consistent users. However, as overall odds ratios were still greater than consistent participators at each time point, this difference does not suggest that quitting intramurals lowers absolute risk. We hypothesize that the protective nature of consistent intramural participation may be due to these youth being more health conscious and/or risk adverse as risk behaviors tend to cluster among youth although this warrants further investigation (Laxer et al., 2017). These results are also in line with research that has found team sports to be protective against cannabis use for female adolescents (Boyes et al., 2017). In contrast, consistent participation in community sport (i.e. sports leagues outside of school) has been associated with an increased risk of cannabis use over time among females (Lau et al., 2019) and competitive contact sports participation has been associated with an increased risk of cannabis use over time among males (Veliz et al., 2017). Overall, these contrasting results indicate that further evidence is needed to determine if participation alone is enough to reduce substance use (McKiernan, 2016). As seen in previous research from the Icelandic Model, offering youth consistent regularly programmed youth activities such as intramurals when combined

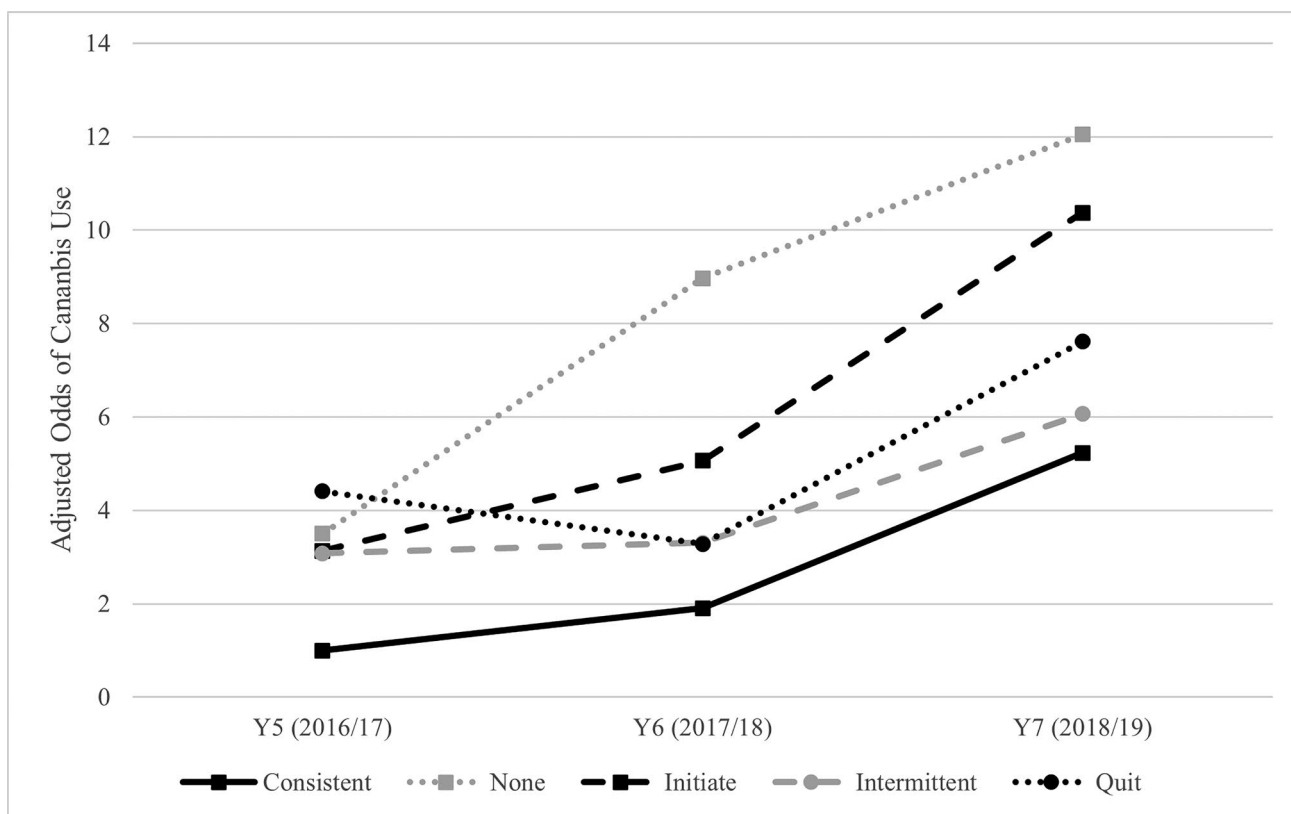


Figure 2. Adjusted odds of cannabis use by intramural participation pattern over time among females in Y5 to Y7 (2016-2018) of the COMPASS study in Canada (n=4,388).

Table 4. Mixed effects logistic regression results between intramural participation pattern over time and odds of substance use over time among males in Y5 to Y7 of the COMPASS study in Canada (2016-2018) (n=3,457).

Variable	Model 1 Binge drinking OR (95% CI)	Model 2 Cannabis use OR (95% CI)	Model 3 Cigarette use OR (95% CI)	Model 4 E-cigarette use OR (95% CI)
Time				
Y5	-	-	-	-
Y6	2.17 (1.74-2.72)	2.02 (1.51-2.71)	1.10 (0.78-1.55)	3.80 (3.07-4.70)
Y7	3.89 (3.08-4.91)	3.48 (2.58-4.68)	0.67 (0.47-0.96)	10.15 (8.03-12.83)
Intramural participation pattern				
Consistent (Ref)	-	-	-	-
None	0.66 (0.47-0.93)	1.97 (1.28-3.02)	1.81 (1.05-3.12)	0.83 (0.59-1.150)
Initiate	0.73 (0.51-1.06)	1.36 (0.85-2.18)	1.55 (0.84-2.84)	0.87 (0.60-1.25)
Intermittent	0.93 (0.64-1.36)	1.85 (1.14-3.00)	1.55 (0.83-2.90)	1.06 (0.72-1.56)
Quit	0.82 (0.58-1.16)	1.51 (0.97-2.37)	1.97 (1.12-3.45)	1.25 (0.89-1.78)

OR=Odds Ratio; CI=Confidence Interval; The odds ratios represent the multiplicative increase in odds of use in the stated category compared to the reference category. Results controlled for grade, ethnicity, spending money, other substance use, school connectedness, varsity participation, province, school neighborhood median income, and urbanicity.

with other intervention components resulted in decreases in substance use (Sigfúsdóttir et al., 2009).

Quitting intramurals was associated with increased odds of cigarette use among all students. As these students had an increased risk of cigarette use at baseline, before quitting intramurals, these results suggest that cigarette use preceded quitting intramurals. Additionally, no participation was associated with an increased risk among male students. These associations did not vary with time. This finding is in line with other literature. Cigarette use has consistently been negatively associated with sports participation (Lisha & Sussman,

2010; Veliz et al., 2017). This is likely due to the well-known negative health effects of cigarette use and the immediate physical impairments (i.e. shortness of breath) that negatively impact physical activity (U. S. Department of Health & Human Services, 2014). However, it should be noted that the ICC for cigarette use was almost 100%. This indicates that an individual student’s cigarette use in a given year is highly dependent on that student’s use in previous years, suggesting that intramural participation is not necessarily driving this behavior. Therefore, cigarette use could be driving the lack of intramural participation or some third factor could be

driving both. There were no associations between intramural participation and e-cigarette use among female or male students. To date, there is evidence linking e-cigarettes use and sports but this has typically been for more competitive sports (Milicic et al., 2019; Veliz et al., 2017; Williams et al., 2020). Although this null result could also be explained due to drastic changes in e-cigarette use during this time. From 2016 to 2018, e-cigarette use increased substantially among Canadian youth from 10% to 26% (Cole et al., 2020). This null result suggests that the increase in consumption was pervasive across all intramural groups, perhaps due to the novelty associated with e-cigarette use, the loosening of e-cigarette regulations in Canada in 2018, and the subsequent increase in exposure to e-cigarette advertising among youth (Hammond et al., 2020). It is possible we will see a different association as usage rates stabilize.

Intramurals may be a current missed opportunity to equitably and cost-effectively target youth substance use. Given how few students in our study consistently reported participating in intramurals annually (less than 1 in 6 students), there is ample room for improvement of this modifiable behavior among the student population. Additionally, while the current research suggests consistent participation may help reduce the use of cigarettes and cannabis, the same cannot be said for alcohol. Male students who did not participate were less likely to binge drinking than those who participated consistently. Intramurals present a potential target for alcohol prevention. Many of the current sport-related approaches to reducing substance use are education-based programming targeted toward the use of performance enhancing drugs and diet pills (McKiernan, 2016). These approaches could be extended to include education around recreational substances (i.e. tobacco, cannabis, and alcohol). Efforts including personalized feedback and social norming approaches have been found to be more effective at reducing alcohol use compared to education-only programs, however they require more resources (McKiernan, 2016).

It should also be noted that despite promising results for consistent intramural participation for cannabis and cigarette use, we identified substantial ICC values for substance use over time, especially for cigarette use. This means that observations across years were highly correlated and students were consistent in their behavior over time. Therefore, once students start using a substance, they may be less likely to change this behavior and intramural participation may not be driving this relationship. This finding could also suggest that the substance use behaviors were developed prior to the start of the study period. Future research should examine how changes in intramural participation are associated with both initiation of substance use and subsequent changes in frequency to better explain the relationships found in the current study.

Limitations

The main limitation of the COMPASS sample is the use of purposive sampling, which may limit the generalizability of results. However, the COMPASS study has a large sample size and uses an active-information, passive-consent protocol

to encourage participation and honest reporting (Thompson-Haile et al., 2013). This has been shown to be particularly important for producing robust results that limit self-selection and response bias, particularly for measures of substance use behaviors (Leatherdale et al., 2014; Rojas et al., 2008; White et al., 2004). Due to the rolling sample design of the COMPASS study, we were not able to follow all students over time. 26,859 students participated in the baseline year and 8,859 participants were successfully linked for all 3 years. Students who were linked were less likely to report substance use and more likely to report intramural participation at baseline. As such, this study may understate true substance use rates. Additionally, this research was not able to identify how many or which types of intramurals students participated in. Future research should examine intramurals by type and frequency. Moreover, due to the meaningful within-student correlation identified and the lack of interaction with time seen in the models, we cannot conclusively determine if changes in intramural participation are causing substance use behaviors or if a third factor is influencing this relationship. Nevertheless, this study uses longitudinal data to help fill a gap in Canadian research on relationship between sport and substance use among youth (Canadian Centre on Substance Use & Addiction, 2017).

Conclusions

No intramural participation was found to be a protective factor for binge drinking and a risk factor for cannabis use and cigarette use among males. Results were more nuanced for female students. No participation was a risk factor for cigarette use, while any participation that was not consistent all three years was a risk factor for cannabis use.

Intramural participation was not associated with e-cigarette use among students. Significant differences over time by intramural group were only identified for cannabis use among female students. When planning sport-centered substance use prevention programming, it may be important to take into consideration how intramural sport participation is uniquely associated with different substances. Encouraging consistent intramural participation among high school students may help to reduce cannabis and cigarette use among male students.

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Declaration of interest

The authors report no conflict of interest.

Authors' contributions

All authors contributed to the conception of the study research questions. GCW performed the statistical analysis, with the guidance of KB. GCW and KEB wrote the manuscript and KB, MdG, YJ, and STL

revised the manuscript for important intellectual content. STL conceived of the COMPASS study and wrote the funding proposal, developed the study tools, and is leading the study implementation and coordination. All authors read and approved of the final manuscript.

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Data availability statement

The datasets generated and analyzed during the current study will not currently be shared because this is an ongoing study; however, access to the data supporting the findings of the study can be requested at <https://uwaterloo.ca/compass-system/information-researchers>.

References

- Anderson, P., Bruijn, A. D., Angus, K., Gordon, R., & Hastings, G. (2009). Impact of Alcohol Advertising and Media Exposure on Adolescent Alcohol Use : A Systematic Review of Longitudinal studies. *Alcohol and Alcoholism (Oxford, Oxfordshire)*, 44(3), 229–243. <https://doi.org/10.1093/alcac/agn115>
- Barnes, J. D., Cameron, C., Carson, V., Chaput, J.-P., Colley, R. C., Faulkner, G. E. J., Janssen, I., Kramers, R., Saunders, T. J., Spence, J. C., Tucker, P., Vanderloo, L. M., & Tremblay, M. S. (2018). Results from Canada's 2018 Report Card on Physical Activity for Children and Youth. *Journal of Physical Activity and Health*, 15(s2), S328–S330. <https://doi.org/10.1123/jpah.2018-0454>
- Battista, K., Qian, W., Bredin, C., Leatherdale, S. T. (2019). Student Data Linkage over Multiple Years. Retrieved from <https://uwaterloo.ca/compass-system/student-data-linkage-over-multiple-years>
- Biddle, S. J. H., Ciacconi, S., Thomas, G., & Vergeer, I. (2019). Physical activity and mental health in children and adolescents : An updated review of reviews and an analysis of causality. *Psychology of Sport and Exercise*, 42, 146–155. <https://doi.org/10.1016/j.psychsport.2018.08.011>
- Boyes, R., O'Sullivan, D. E., Linden, B., McIsaac, M., & Pickett, W. (2017). Gender-specific associations between involvement in team sport culture and canadian adolescents' substance-use behavior. *SSM - Population Health*, 3, 663–673. <https://doi.org/10.1016/j.ssmph.2017.08.006>
- Bredin, C., Leatherdale, S. T. (2014). Development of the COMPASS Student Questionnaire. <https://doi.org/https://uwaterloo.ca/compass-system/publications/development-compass-student-questionnaire>
- Brown, K. (2016). Association Between Alcohol Sports Sponsorship and Consumption : A Systematic Review. *Alcohol and Alcoholism (Oxford, Oxfordshire)*, 51(6), 747–755. <https://doi.org/10.1093/alcac/agg006>
- Butler, A., Romano, I., Patte, K., Ferro, M. A., Groh, M. D., Jiang, Y., & Leatherdale, S. T. (2019). Psychological correlates and binge drinking behaviours among Canadian youth : a cross-sectional analysis of the mental health pilot data from the COMPASS study. *BMJ Open* 9(6), 1–10. <https://doi.org/10.1136/bmjopen-2018-028558>
- Canadian Centre on Substance Use and Addiction (2017). Youth Sport Participation and Substance Use : Understanding the Relationship. Retrieved April 6, 2020, from <https://www.ccsa.ca/sites/default/files/2019-04/CCSA-Youth-Sport-and-Substance-Use-Summary-2017-en.pdf>
- Canadian Society for Exercise Physiology. (2017). Canadian 24-Hour Movement Guidelines for Children and Youth (ages 5-17 years): An Integration of Physical Activity, Sedentary Behaviour and Sleep. Retrieved from https://csepguidelines.ca/wp-content/themes/csep2017/pdf/Canadian24HourMovementGuidelines2016_2.pdf
- Cole, A. G., Aleyan, S., Battista, K., & Leatherdale, S. T. (2020). Trends in youth e-cigarette and cigarette use between 2013 and 2019 : insights from repeat cross-sectional data from the COMPASS study. *Canadian Journal of Public Health*, 112(1), 60–69. <https://doi.org/10.17269/s41997-020-00389-0>
- Colley, R. C., Carson, V., Garriguet, D., Janssen, I., Roberts, K. C., & Tremblay, M. S. (2017). Physical activity of Canadian children and youth, 2007-2015. *Health Reports*, 28(10), 8–16.
- Connor, K. D., Martin, J. L., & Martens, M. P. (2007). Social norms and alcohol consumption among intercollegiate athletes : The role of athlete and nonathlete reference groups. *Addictive Behaviors*, 32(11), 2657–2666. <https://doi.org/10.1016/j.addbeh.2007.04.030>
- Contardo Ayala, A., Salmon, J., Dunstan, D., Arundell, L., Parker, K., Timperio, A., ... Timperio, A. (2018). Longitudinal Changes in Sitting Patterns, Physical Activity, and Health Outcomes in Adolescents. *Children*, 6(1), 2. <https://doi.org/10.3390/children6010002>
- Denault, A., & Poulin, F. (2018). A detailed examination of the longitudinal associations between individual and team sports and alcohol use. *Addictive Behaviors*, 78, 15–21. <https://doi.org/10.1016/j.addbeh.2017.10.019>
- Edwards, M. B., Kanters, M. A., & Bocarro, J. N. (2014). Policy Changes to Implement Intramural Sports in North Carolina Middle Schools : Simulated Effects on Sports Participation Rates and Physical Activity Intensity, 2008-2009. *Preventing Chronic Disease*, 11(1), 130195–130198. <https://doi.org/10.5888/pcd11.130195>
- Elton-Marshall, T., Leatherdale, S. T., Manske, S. R., Wong, K., Ahmed, R., & Burkhalter, R. (2011). Research methods of the youth smoking survey (YSS). *Chronic Diseases and Injuries in Canada*, 32(1), 47–54.
- Fitzmaurice, G. M., Laird, N. M., & Ware, J. H. (2011). *Applied Longitudinal Analysis*. (2nd Editio). John Wiley & Sons, Inc. <https://doi.org/10.1002/9781119513469>
- Ford, J. A. (2007). Alcohol Use among College Students: A Comparison of Athletes and Nonathletes. *Substance Use & Misuse*, 42(9), 1367–1377. <https://doi.org/10.1080/10826080701212402>
- Fuller, D., Sabiston, C., Karp, I., Barnett, T., & O'Loughlin, J. (2011). School Sports Opportunities Influence Physical Activity in Secondary School and Beyond. *The Journal of School Health*, 81(8), 449–454. <https://doi.org/10.1111/j.1746-1561.2011.00613.x>
- Godin, K. M., Chaurasia, A., Hammond, D., & Leatherdale, S. T. (2018). Food Purchasing Behaviors and Sugar-Sweetened Beverage Consumption among Canadian Secondary School Students in the COMPASS Study. *Journal of Nutrition Education and Behavior*, 50(8), 803–812.e1. <https://doi.org/10.1016/j.jneb.2017.12.014>
- Hammond, D., Reid, J. L., Burkhalter, R., & Rynard, V. L. (2020). E-cigarette Marketing Regulations and Youth Vaping : Cross-Sectional Surveys. *Pediatrics*, 146(1), e20194020. <https://doi.org/10.1542/peds.2019-4020>
- Harding, S. K., Page, A. S., Falconer, C., & Cooper, A. R. (2015). Longitudinal changes in sedentary time and physical activity during adolescence. *International Journal of Behavioral Nutrition and Physical Activity*, 12(1), 44. <https://doi.org/10.1186/s12966-015-0204-6>
- Hebert, J. J., Møller, N. C., Andersen, L. B., & Wedderkopp, N. (2015). Organized Sport Participation Is Associated with Higher Levels of

- Overall Health-Related Physical Activity in Children (CHAMPS Study-DK). <https://doi.org/10.1371/journal.pone.0134621>
- Hobin, E. P., Leatherdale, S., Manske, S., Dubin, J. A., Elliott, S., & Veugelers, P. (2013). Are Environmental Influences on Physical Activity Distinct for Urban, Suburban, and Rural Schools? A Multilevel Study Among Secondary School Students in Ontario, Canada. *The Journal of School Health*, 83(5), 357–367. <https://doi.org/10.1111/josh.12039>
- Janssen, I., & Leblanc, A. G. (2010). Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *International Journal of Behavioral Nutrition and Physical Activity*, 7(1), 40. <https://doi.org/10.1186/1479-5868-7-40>
- Janssen, I., Roberts, K. C., & Thompson, W. (2017). Adherence to the 24-Hour Movement Guidelines among 10- to 17-year-old Canadians. *Health Promotion and Chronic Disease Prevention in Canada*, 37(11), 369–375. <https://doi.org/10.24095/hpcdp.37.11.01>
- Kurc, A. R., & Leatherdale, S. T. (2009). The Effect of Social Support and School- and Community-based Sports on Youth Physical Activity. *Canadian Journal of Public Health = Revue Canadienne de Sante Publique*, 100(1), 60–64. <https://doi.org/10.1007/BF03405495>
- Lau, E. Y., Riazi, N. A., Qian, W., Leatherdale, S. T., & Faulkner, G. (2019). Protective or risky? The longitudinal association of team sports participation and health-related behaviours in Canadian adolescent girls. *Canadian Journal of Public Health = Revue Canadienne de Sante Publique*, 110(5), 616–625. <https://doi.org/10.17269/s41997-019-00221-4>
- Laxer, R. E., Brownson, R. C., Dubin, J. A., Cooke, M., Chaurasia, A., & Leatherdale, S. T. (2017). Clustering of risk-related modifiable behaviours and their association with overweight and obesity among a large sample of youth in the COMPASS study. *BMC Public Health*, 17(1), 102. <https://doi.org/10.1186/s12889-017-4034-0>
- Leatherdale, S. T., Brown, K. S., Carson, V., Childs, R. A., Dubin, J. A., Elliott, S. J., Faulkner, G., Hammond, D., Manske, S., Sabiston, C. M., Laxer, R. E., Bredin, C., & Thompson-Haile, A. (2014). The COMPASS study: A longitudinal hierarchical research platform for evaluating natural experiments related to changes in school-level programs, policies and built environment resources. *BMC Public Health*, 14, 331. <https://doi.org/10.1186/1471-2458-14-331>
- Lisha, N. E., & Sussman, S. (2010). Relationship of high school and college sports participation with alcohol, tobacco, and illicit drug use: A reviews. *Addict Behav*, 35(5), 399–407. <https://doi.org/10.1016/j.addbeh.2009.12.032>
- Lister-Sharp, D., Chapman, S., Stewart-Brown, S., & Sowden, A. (1999). Health promoting schools and health promotion in schools: Two systematic review. *Health Technology Assessment*, 3(22), 1–207. <https://doi.org/10.3310/hta3220>
- McKiernan, A. (2016). Youth Sport Programs that Address Substance Use — An Environmental Scan Youth Sport Programs that Address Substance Use — An Environmental Scan. Retrieved April 6, 2020, from <https://www.ccsa.ca/sites/default/files/2019-04/CCSA-Sport-Programs-Substance-Use-Education-Report-2016-en.pdf>
- Milicic, S., Decicca, P., Pierard, E., & Leatherdale, S. T. (2018). An evaluation of school-based e-cigarette control policies 'impact on the use of vaping products, Tobacco Induced Diseases, 16 (August), 35.
- Milicic, S., Piérard, E., Decicca, P., & Leatherdale, S. T. (2019). Examining the Association Between Physical Activity, Sedentary Behavior and Sport Participation With E-Cigarette Use and Smoking Status in a Large Sample of Canadian Youth. *Nicotine & Tobacco Research : official Journal of the Society for Research on Nicotine and Tobacco*, 21(3), 285–292. <https://doi.org/10.1093/ntr/ntx238>
- Modecki, K. L., Ph, D., Barber, B. L., Ph, D., Eccles, J. S., & Ph, D. (2014). Binge Drinking Trajectories Across Adolescence : For Early Maturing Youth, Extra-Curricular Activities Are protective. *The Journal of Adolescent Health : official Publication of the Society for Adolescent Medicine*, 54(1), 61–66. <https://doi.org/10.1016/j.jadohealth.2013.07.032>
- Montreuil, A., MacDonald, M., Asbridge, M., Wild, T. C., Hammond, D., Manske, S., & Rutherford, E. (2017). Prevalence and correlates of electronic cigarette use among Canadian students: Cross-sectional findings from the 2014/15 Canadian Student Tobacco, Alcohol and Drugs Survey. *CMAJ Open*, 5(2), E460–E467. <https://doi.org/10.9778/cmajo.20160167>
- Morojele, N. K., Lombard, C., Burnhams, N. H., Williams, P. P., Nel, E., & Parry, C. D. H. (2018). Alcohol marketing and adolescent alcohol consumption : Results from the International Alcohol Control study (South Africa) *South African Medical Journal = Suid-Afrikaanse Tydskrif Vir Geneeskunde*, 108(9), 782–788. <https://doi.org/10.7196/SAMJ.2018.v108i9.12958>
- National Institute on Drug Abuse (2015). Pro Athletes, Marijuana, and Opioids.
- Physical Activity Guidelines Advisory Committee. *Physical Activity Guidelines Advisory Committee* (2018). *Scientific Report*. Washington, DC. Retrieved from https://health.gov/sites/default/files/2019-09/PAG_Advisory_Committee_Report.pdf
- Qian, W., Battista, K., Bredin, C., Brown, K. S., Leatherdale, S. T. (2015). Assessing longitudinal data linkage results in the COMPASS study. Retrieved from <https://uwaterloo.ca/compass-system/publications/assessing-longitudinal-data-linkage-results-compass-study>
- Reardon, C., & Creado, S. (2014). Drug abuse in athletes. *Substance Abuse and Rehabilitation*, 5(13), 95–105. <https://doi.org/10.2147/sar.s53784>
- Roberts, K. C., Yao, X., Carson, V., Chaput, J., Janssen, I., & Tremblay, M. S. (2017). Meeting the Canadian 24-Hour Movement Guidelines for Children and Youth. *Health Reports*, 28(10), 3–7.
- Rojas, N. L., Sherrit, L., Harris, S., & Knight, J. R. (2008). The Role of Parental Consent in Adolescent Substance Use Research. *Journal of Adolescent Health*, 42(2), 192–197. <https://doi.org/10.1016/j.jadohealth.2007.07.011>
- Romano, I., Williams, G., Butler, A., Aleyan, S., Patte, K. A., & Leatherdale, S. T. (2019). Psychological and Behavioural Correlates of Cannabis use among Canadian Secondary School Students: Findings from the COMAPSS Study. *Canadian Journal of Addiction*, 10(3), 10–21. <https://doi.org/10.1097/CXA.0000000000000058>
- Sallis, J. F., Prochaska, J. J., & Taylor, W. C. (2000). A review of correlates of physical activity of children and adolescents. *Medicine and Science in Sports and Exercise*, 32(5), 963–975.
- Sigfúsdóttir, I. D., Thorlindsson, T., Kristjánsson, Á. L., Roe, K. M., & Allegrante, J. P. (2009). Substance use prevention for adolescents: The Icelandic Model. *Health Promotion International*, 24(1), 16–25. <https://doi.org/10.1093/heapro/dan038>
- Statistics Canada (2016a). Census Profile. Retrieved from https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/download-telecharger/comp/page_dl-tc.cfm?Lang=E
- Statistics Canada (2016b). GeoSearch. Retrieved from <https://www12.statcan.gc.ca/census-recensement/2016/geo/geosearch-georecherche/index-eng.cfm>
- Telford, R. M., Telford, R. D., Cochrane, T., Cunningham, R. B., Olive, L. S., & Davey, R. (2016). The influence of sport club participation on physical activity, fitness and body fat during childhood and adolescence: The LOOK Longitudinal Study. *Journal of Science and Medicine in Sport*, 19(5), 400–406. <https://doi.org/10.1016/j.jsams.2015.04.008>
- Terry-McElrath, Y. M., O'Malley, P. M., & Johnston, L. D. (2011). Exercise and substance use among american youth, 1991-2009. *American Journal of Preventive Medicine*, 40(5), 530–540. <https://doi.org/10.1016/j.amepre.2010.12.021>
- Thompson-Haile, A., Bredin, C., Leatherdale, S. T. (2013). Rationale for using active-information passive-consent permission protocol in COMPASS. Retrieved from <https://uwaterloo.ca/compass-system/publications/rationale-using-active-information-passive-consent>
- Thompson-Haile, A., Leatherdale, S. T. (2013). Student-level Data Collection Procedures. Retrieved from <https://uwaterloo.ca/compass-system/publications/student-level-data-collection-procedures>
- Timperio, A., Salmon, J., & Ball, K. (2004). Evidence-based strategies to promote physical activity among children, adolescents and young adults: Review and update. *Journal of Science and Medicine in Sport*, 7(1), 20–29. [https://doi.org/10.1016/S1440-2440\(04\)80274-3](https://doi.org/10.1016/S1440-2440(04)80274-3)
- U. S. Department of Health and Human Services (2012). *Physical Activity Guidelines for Americans Midcourse Report : Strategies to Increase Physical Activity Among Youth*. Washington, DC. Retrieved

- from <https://health.gov/sites/default/files/2019-09/pag-mid-course-report-final.pdf>
- U. S. Department of Health and Human Services. (2014). *The Health Consequences of Smoking—50 Years of Progress: A Report of the Surgeon General*. Retrieved from <https://www.surgeongeneral.gov/library/reports/50-years-of-progress/exec-summary.pdf>
- van Mechelen, W., Twisk, J. W., Post, G. B., Snel, J., & Kemper, H. C. (2000). Physical activity of young people : the Amsterdam Longitudinal Growth and Health Study. *Medicine and Science in Sports and Exercise*, 32(9), 1610–1616. <https://doi.org/10.1097/00005768-200009000-00014>
- Veliz, P., McCabe, S. E., McCabe, V. V., & Boyd, C. J. (2017). Adolescent Sports Participation, E-cigarette Use, and Cigarette Smoking. *American Journal of Preventive Medicine*, 53(5), e175–e183. <https://doi.org/10.1016/j.amepre.2017.06.032>
- Veliz, P., Schulenberg, J., Patrick, M., Kloska, D., McCabe, S. E., & Zarrett, N. (2017). Competitive sports participation in high school and subsequent substance use in young adulthood : Assessing differences based on level of contact. *International Review for the Sociology of Sport*, 52(2), 240–259. <https://doi.org/10.1177/1012690215586998>
- White, V. M., Hill, D. J., & Effendi, Y. (2004). How does active parental consent influence the findings of drug-use surveys in schools. *Evaluation Review*, 28(3), 246–260. <https://doi.org/10.1177/0193841X03259549>
- Williams, G. C., Burns, K. E., Battista, K., Groh, M., De, Jiang, Y., & Leatherdale, S. T. (2020). High school sport participation and substance use : A cross-sectional analysis of students from the COMPASS study. *Addictive Behaviors Reports*, 12(August), 100298. <https://doi.org/10.1016/j.abrep.2020.100298>
- Windle, M. (2016). Drinking Over the Lifespan: Focus on Early Adolescents and Youth. *Alcohol Research: Current Reviews*, 38(1), 95–101. Retrieved from <https://www.arcr.niaaa.nih.gov/arcr381/article11.htm>
- Wong, S. L., Shields, M., Leatherdale, S., Malaison, E., & Hammond, D. (2012). Assessment of validity of self-reported smoking status. *Health Reports*, 23(1), 47–53. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/22590805>
- Zuckermann, A. M. E., Williams, G. C., Battista, K., Jiang, Y., de Groh, M., & Leatherdale, S. T. (2020). Prevalence and Correlates of Youth Poly-Substance Use in the COMPASS Study. *Addict Behav*, 107, 106400. <https://doi.org/10.1016/j.addbeh.2020.106400>