



An examination of how age of onset for alcohol, cannabis, and tobacco are associated with physical activity, screen time and BMI as students are preparing to graduate from high school

Gillian C. Williams*, Kate Battista, Scott T. Leatherdale

School of Public Health and Health Systems, University of Waterloo, Waterloo, ON, Canada

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ABSTRACT

Introduction: In this study we examined the co-occurrence of alcohol, cannabis, and tobacco among a large cohort of grade 12 students in Canada, and then explored if the age of initiation of these substances was associated with moderate-to-vigorous physical activity (MVPA), screen time, and BMI.

Methods: This cross-sectional study used student-level data from grade 12 students in years 1 to 5 (2012–2016) of the COMPASS study. Random intercept linear regression models were used to examine the impact of age of initiation of alcohol, cannabis, and tobacco use on student average daily physical activity, daily screen time and BMI.

Results: Twenty-eight percent of students had only tried one substance with alcohol being the most reported single substance used (25%). The most common co-occurrence was students reporting having tried all three substances (27%). Nineteen percent of students reported no substance use by grade 12.

Younger age of first use of alcohol was associated with increased MVPA in grade 12. Earlier initiation of cannabis and tobacco were associated with increased screen time in grade 12. Age of first use of alcohol, cannabis and tobacco were not associated with BMI in grade 12.

Conclusion: While no specific cut-off age was identified this study indicates that for every year tobacco and cannabis use are delayed among children, there are subsequent reductions to screen time in grade 12. Early initiation of alcohol was associated with increased MVPA in grade 12. Early initiation of alcohol, cannabis and tobacco were not associated with BMI in grade 12.

1. Introduction

High school is when many youths begin to experiment with tobacco, alcohol, or cannabis. According to the 2014–2015 Canadian Student Tobacco, Alcohol and Drug Survey, 67% of Canadian youth in grade 12 reported drinking alcohol in the past year, 33% reported using cannabis in the past year and 9% reported being a current smoker (daily or occasional) (Government of Canada, 2016). In Canada, the average age of initiation is 13.5 for alcohol and tobacco and 14.2 for cannabis (Government of Canada, 2016). These substances are associated with acute and chronic health consequences and there is increased risk the earlier substance use is initiated (Butt et al., 2011; Cobb-Clark et al., 2015; Mason and Spoth, 2012; Nelson et al., 2015; Patton et al., 2002; Richmond-Rakerd et al., 2017). Furthermore, many youths are experimenting with multiple substances (Leatherdale and Burkhalter, 2012). Results from the 2008–2009 Youth Smoking Survey indicate that while

12% of students in grades 7–12 reported the use of only one substance, the same number reported concurrent substance use (Leatherdale and Burkhalter, 2012). This highlights the need to examine both age of first use and comorbid use when studying substance use among youth.

Additionally, research has linked substance use and obesity in youth (Farhat et al., 2010; Huang et al., 2013). There is evidence that adolescent alcohol use contributes to subsequent poor body composition in young adulthood (Pasch et al., 2012). Binge drinking is a particularly problematic pattern of use among youth (Chung et al., 2018) and youth who engage in binge drinking once per month are consuming as many as 13,200 additional Calories per year (Battista and Leatherdale, 2017). This suggests that reducing substance use rates among Canadian youth may contribute to a reduction in overweight and obesity. Currently 34% of Canadian adolescents aged 12 to 17 years are living with overweight or obesity (Statistics Canada, 2015). Adolescent obesity is associated with both metabolic risk factors in adolescence and an

* Corresponding author at: School of Public Health and Health Systems, University of Waterloo, 200 University Ave W, Waterloo, ON N2L 3G1, Canada.
E-mail address: gillian.williams@uwaterloo.ca (G.C. Williams).

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increased risk of obesity and other chronic diseases in adulthood (Reilly et al., 2003). Overweight youth tend to also be at higher risk for poor social and economic outcomes (Reilly et al., 2003).

Other modifiable behaviours that are associated with substance use include moderate-to-vigorous physical activity (MVPA) and screen time (Carson et al., 2011; Tabak et al., 2015). In addition to body composition improvements, MVPA benefits youth's cardiovascular and metabolic risk factors, motor skills, and academic outcomes (Donnelly and Lambourne, 2011; Janssen and Leblanc, 2010). In contrast, elevated screen time is associated with increased adiposity, metabolic syndrome, and anxiety and depression in adolescents (Bai et al., 2016; Maras et al., 2015). It is recommended that adolescents accumulate at least 60 min per day of MVPA and no more than 2 h per day of recreational screen time (Tremblay et al., 2016). Currently, Canadian adolescents aged 12–17 engage in an average of 46 min per day of MVPA and 3.8 h per day of screen time (Roberts et al., 2017).

Prevention programming is typically targeted towards specific behaviours (Michie et al., 2011). However, research has shown that behaviours rarely occur in isolation and comprehensive programming may be a better approach (Laxer et al., 2017; Michie et al., 2011). As such, it is important to understand the relationships between different risk behaviours among youth. Therefore, this study had two objectives. First, we examined student use and co-use of alcohol, cannabis, and cigarettes among a large cohort of grade 12 students. Second, we then explored if the age of initiation of these substances was associated with MVPA, screen time, and BMI.

2. Methods

2.1. Study

The COMPASS host study is an ongoing prospective cohort study (2012–2021) of a convenience sample of secondary school students in five provinces and territories in Canada (Ontario, Alberta, British Columbia, Quebec, and Nunavut). (Leatherdale et al., 2014a, 2014b) The study collects longitudinal, hierarchical data to examine the influence of the school environment on student health outcomes including physical activity, healthy eating, bullying, and tobacco, alcohol and cannabis use. Details on the COMPASS host study, including sampling and data collection, are available online (www.compass.uwaterloo.ca). The COMPASS study was approved by the Human Research Ethics Board at the University of Waterloo (reference number: 17264).

2.2. Participants

The current study used student-level data from grade 12 students in years 1 to 5 (2012–2016) of the COMPASS study. The study used active-information, passive-consent permission protocols, which is important for collecting unbiased data within studies examining youth substance use (White et al., 2004). Parents were sent study information via mailed letter or automated phone call, and could choose to withdraw their child from the study by contacting the COMPASS recruitment coordinator. All students within a participating school were invited to participate in the study and students could refuse to participate at any time. Participating students completed the COMPASS student questionnaire (Cq), which is a paper-based, self-administered, anonymous survey. The current study examined Cq data from 42,355 grade 12 students enrolled in 106 schools across years 1–5 of the COMPASS study. Response rates from years 1–5 of the COMPASS study were Y1: 79%, Y2: 79%, Y3: 79%, Y4: 80%, and Y5: 77%. Students with missing data on age of substance use information or control variables were excluded from the study, resulting in a final sample of 35,221 students. A comparison of students with complete versus missing data can be found in Appendix Tables 1 and 2. Students with missing data on any of the outcome measures were excluded from the corresponding analyses.

2.3. Measures

The Cq uses previously validated measures (Leatherdale et al., 2014a, 2014b; Leatherdale and Laxer, 2013; Wong et al., 2006, 2012) and measures used in national youth substance use surveillance in Canada (Bredin and Leatherdale, 2014; Elton-Marshall et al., 2011).

2.3.1. Age of substance use initiation

To determine the age at which students first used tobacco, students were asked the question, “How old were you when you first tried smoking cigarettes, even just a few puffs?” Similarly, to determine age of first use of alcohol, students were asked “How old were you when you first had a drink of alcohol that was more than just a sip?” To determine age of first use of cannabis, students were asked, “How old were you when you first used marijuana or cannabis”. Students could respond that they have never used the substance or did not know the age of first use or could select an age from “8 years or younger” to “18 years or older”. Students answering, “I do not know” were excluded from the analysis. Tables comparing respondents with those who did not answer or responded “I do not know” on age of first use variables have been added to an Appendix.

2.3.2. Daily physical activity

Students were asked to indicate the number of minutes spent doing hard and moderate physical activity on each of the last 7 days. To assist in reporting, examples of hard and moderate physical activities were provided. Response options for each day and each activity level (hard/moderate) ranged in 15 min increments from 0 min to 4 h and 45 min. Time spent doing hard and moderate physical activity were combined for each day and then averaged to determine average daily minutes of physical activity.

2.3.3. Daily screen time

To assess screen time, students were asked to indicate the number of minutes usually spent (1) watching/streaming TV shows or movies, (2) playing video/computer games, (3) talking on the phone, (4) surfing the internet and (5) texting, messaging, emailing. Response options for each activity ranged in 15 min increments from 0 min to 9 h, 45 min. The amount of time spent on each activity was summed to determine students' usual total daily screen time.

2.3.4. Body mass index (BMI)

Students were asked to report their height and body weight. Self-reported height (in meters) and weight (in kilograms) were then used to calculate Body Mass Index (BMI) as a continuous measure of weight status. Height and weight measures were previously validated in a sample of grade 9 students (Leatherdale and Laxer, 2013).

2.3.5. Control variables

Students were asked to indicate their sex, ethnicity, weekly spending money, and current substance use. Year of data collection (2012–2016) was also used as a control variable.

2.4. Analysis

Descriptive statistics were calculated for all measures and Chi-square and *t*-tests were used to examine differences between males and females in the sample. Frequencies were calculated to examine substance use co-occurrence.

Random intercept linear regression models were used to examine the impact of age of initiation of tobacco, alcohol and cannabis use on student average daily physical activity, daily screen time and BMI. Random intercept models were used to account for the clustering of students within schools, based on the assumption that students within the same school are more alike than students from different schools. To satisfy the normality assumption, average daily physical activity and

Table 1
Characteristics of grade 12 students in years 1 to 5 (2012–2016) of the COMPASS study (n = 35,221) in Canada.

Variable	Levels	Total		Females (n = 17,953, 51%)		Males (n = 17,268, 49%)		Chi-square p-value
		n	%	n	%	n	%	
Data collection year	2012	4906	13.9%	2470	13.8%	2436	14.1%	p = .5291
	2013	8579	24.4%	4338	24.2%	4241	24.6%	
	2014	7539	21.4%	3879	21.6%	3660	21.2%	
	2015	7179	20.4%	3646	20.3%	3533	20.5%	
	2016	7018	19.9%	3620	20.2%	3398	19.7%	
Ethnicity	White	27,898	79.2%	14,562	81.1%	13,336	77.2%	p < .0001
	Black	1604	4.6%	659	3.7%	945	5.5%	
	Asian	2305	6.5%	1162	6.5%	1143	6.6%	
	Indigenous	1029	2.9%	504	2.8%	525	3.0%	
	Latin American/Hispanic	866	2.5%	404	2.3%	462	2.7%	
Spending money	Other/mixed	1519	4.3%	662	3.7%	857	5.0%	p < .0001
	Zero	3876	11.0%	1780	9.9%	2096	12.1%	
	\$1 to \$20	5838	16.6%	3022	16.8%	2816	16.3%	
	\$21 to \$100	10,787	30.6%	6034	33.6%	4753	27.5%	
	More than \$100	11,277	32.0%	5370	29.9%	5907	34.2%	
Current drinker	Don't know	3443	9.8%	1747	9.7%	1696	9.8%	p < .0001
	No	17,556	49.8%	9458	52.7%	8098	46.9%	
Current cannabis user	Yes	17,665	50.2%	8495	47.3%	9170	53.1%	p < .0001
	No	27,231	77.3%	14,697	81.9%	12,534	72.6%	
Current smoker	Yes	7990	22.7%	3256	18.1%	4734	27.4%	p < .0001
	No	29,720	84.4%	15,715	87.5%	14,005	81.1%	
Age of first use - alcohol	Yes	5501	15.6%	2238	12.5%	3263	18.9%	p < .0001
	8	1586	4.5%	456	2.5%	1130	6.5%	
	9	271	0.8%	88	0.5%	183	1.1%	
	10	645	1.8%	236	1.3%	409	2.4%	
	11	461	1.3%	177	1.0%	284	1.6%	
	12	1623	4.6%	717	4.0%	906	5.2%	
	13	2784	7.9%	1459	8.1%	1325	7.7%	
	14	5909	16.8%	3234	18.0%	2675	15.5%	
	15	6298	17.9%	3554	19.8%	2744	15.9%	
	16	4990	14.2%	2762	15.4%	2228	12.9%	
	17	1745	5.0%	904	5.0%	841	4.9%	
Age of first use - cannabis	18	326	0.9%	148	0.8%	178	1.0%	p < .0001
	Never used	8583	24.4%	4218	23.5%	4365	25.3%	
	8	539	1.5%	135	0.8%	404	2.3%	
	9	87	0.2%	21	0.1%	66	0.4%	
	10	161	0.5%	49	0.3%	112	0.6%	
	11	180	0.5%	57	0.3%	123	0.7%	
	12	551	1.6%	200	1.1%	351	2.0%	
	13	1284	3.6%	564	3.1%	720	4.2%	
	14	2851	8.1%	1357	7.6%	1494	8.7%	
	15	3619	10.3%	1839	10.2%	1780	10.3%	
	16	4084	11.6%	2153	12.0%	1931	11.2%	
Age of first use - tobacco	17	2139	6.1%	1127	6.3%	1012	5.9%	p < .0001
	18	292	0.8%	131	0.7%	161	0.9%	
	Never used	19,434	55.2%	10,320	57.5%	9114	52.8%	
	8	750	2.1%	228	1.3%	522	3.0%	
	9	154	0.4%	62	0.3%	92	0.5%	
	10	237	0.7%	70	0.4%	167	1.0%	
	11	236	0.7%	108	0.6%	128	0.7%	
	12	691	2.0%	289	1.6%	402	2.3%	
	13	1061	3.0%	508	2.8%	553	3.2%	
	14	2029	5.8%	987	5.5%	1042	6.0%	
	15	2414	6.9%	1191	6.6%	1223	7.1%	
16	3172	9.0%	1608	9.0%	1564	9.1%		
17	2053	5.7%	986	5.4%	1067	6.0%		
18	279	0.8%	111	0.6%	168	0.9%		
Never used	22,749	63.1%	12,027	65.9%	10,722	60.2%		

daily screen time variables were square-root transformed due to the skewed nature of these variables. Appendix Fig. 1-4 compare untransformed and transformed variables. All models controlled for sex, ethnicity, weekly spending money, and data collection year. BMI models also controlled for physical activity and screen time. All models were run using the MIXED procedure in SAS 9.4 (SAS Institute Inc., Cary, NC, USA).

3. Results

3.1. Descriptive statistics

Participant characteristics can be found in Table 1. The majority of students identified as White (79%) and 51% were female. Mean age was 17.2 years. Alcohol use was the most common: 76% of grade 12 students reported having ever tried alcohol and the mean age at which students began use was 14.2 years. Forty-five percent reported ever trying cannabis (mean age of initiation 14.8 years) and 37% tobacco

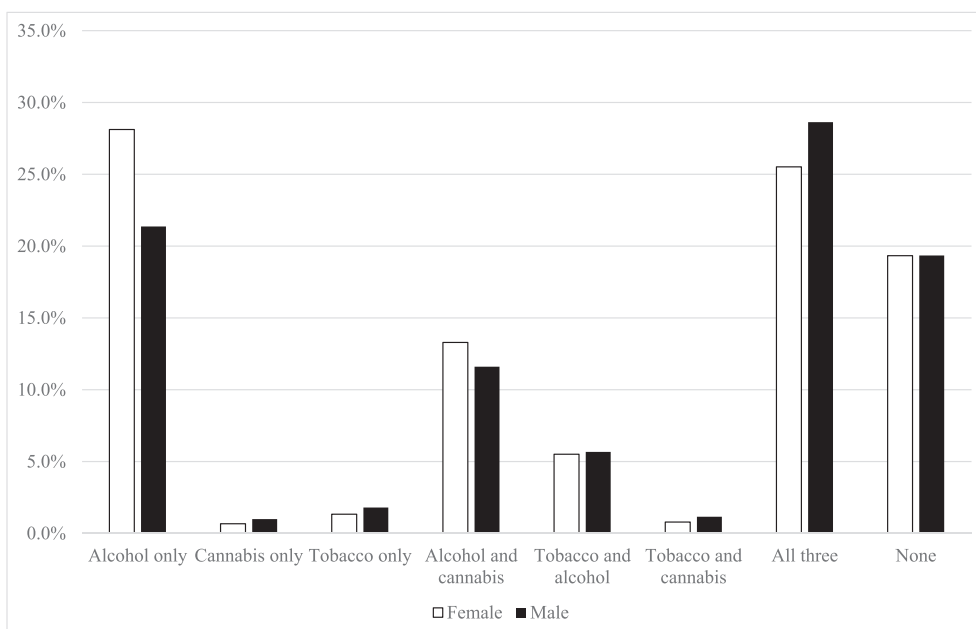


Fig. 1. Proportion of grade 12 students in Canada from years 1 to 5 (2012-2016) of the COMPASS study reporting ever use and co-use of alcohol, cannabis, and tobacco.

(mean age of initiation 14.5 years).

Fig. 1 reports the number of substances students had ever tried by grade 12. Twenty-eight percent of students had only tried one substance with alcohol being the most reported single substance used (25%). Forty-six percent of participants reported trying more than once substance. The most common co-occurrence was students reporting having tried all three substances (27%) followed by students reporting having tried alcohol and cannabis (12%). More females reported trying alcohol only (28% versus 21%) whereas more males reported trying all three substances (29% versus 26%). Nineteen percent of students reported no substance use by grade 12.

Participants engaged in on average 114.5 (standard deviation [SD] 87.8) minutes of MVPA per day and 505.2 (SD 364.3) minutes of screen time per day. Mean BMI of the sample was 23.1 (SD 4.4) (Table 2).

3.2. Regression models

Regression coefficients for the effects of age of initiation of alcohol, cannabis and tobacco on MVPA, screen time, and BMI can be found in Figs. 2 through 4. All models controlled for sex, ethnicity, weekly spending money, current substance use, year of data collection, and clustering by school. Regression coefficients for all models can be found in Appendix Tables 3 - 5.

Age of initiation of alcohol was associated with increased MVPA compared to non-users with those initiating alcohol use at younger ages engaging in more MVPA than those initiating later in adolescence

Table 2

Median, mean, and standard deviation of average daily MVPA in minutes, average daily screen time in minutes, and BMI of grade 12 students in years 1 to 5 (2012-2016) of the COMPASS study (n = 35,221) in Canada.

Variable	Total			Females			Males			t-Test
	Median	Mean	SD	Median	Mean	SD	Median	Mean	SD	
Average daily MVPA (minutes)	96.4	114.5	87.8	83.6	100.0	77.8	113.6	129.7	94.8	p < .0001
Daily screen time (minutes)	420.0	505.2	364.3	364.3	405.0	354.2	420.0	513.3	374.3	P < .0001
BMI	22.2	23.1	4.4	4.4	21.6	4.2	22.9	23.7	4.5	p < .0001

MVPA – moderate to vigorous physical activity.
 BMI – body mass index.

(Fig. 2). No consistent trends were seen for cannabis and tobacco initiation and MVPA. Current drinking was also associated with increased MVPA (p < .0001).

Age of initiation of cannabis and tobacco were associated with increased screen time compared to non-users (Fig. 3). Those initiating cannabis use at younger ages engaged in more screen time than those initiating use at older ages. Initiating alcohol use between the ages of 12 and 16 was associated with decreased screen time compared to non-users. Current alcohol, cannabis and tobacco use were associated with increased screen time (p = .01, p < .0001, p < .0001 respectively).

Tobacco use was associated with increased BMI compared to non-users, however age of initiation did not have an effect (Fig. 4). Current users had a BMI of 0.19 (p = .04) units higher than non-current users. There was no consistent effect of age of initiation of alcohol or cannabis use on BMI although current cannabis users had a 0.18 (p = .03) unit lower BMI on average than non-users.

4. Discussion

This study investigated student substance use among a sample of grade 12 students in years 1 through 5 (2012-2016) of the COMPASS study. This was first investigated descriptively by examining the percentages of students who had tried alcohol, cannabis, tobacco, or some combination of those substances by grade 12. The association between the age at first use and MVPA, screen time, and BMI in grade 12 was then assessed.

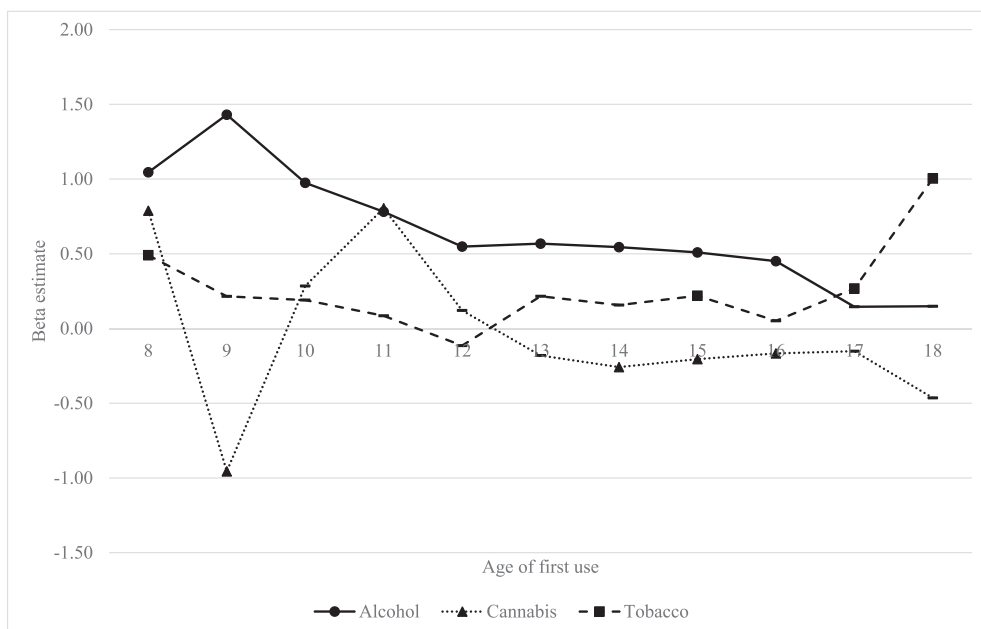


Fig. 2. Plotted beta estimates from the regression models of age of first use of alcohol, cannabis and tobacco on average daily minutes of MVPA (square root transformed) of grade 12 students in Canada from years 1 to 5 (2012-2016) of the COMPASS study. All models controlled for sex, ethnicity, weekly spending money, current substance use, and data collection year. The markers have been replaced with a dash (-) at ages that are not significant at $p < 0.05$.

By the time COMPASS students were in their last year of high school, the vast majority had tried one or more substances. Consistent with previous research, among users, alcohol was the most common substance used, and it was hard to find a student who smoked tobacco or cannabis who had not also used alcohol (Leatherdale and Burkhalter, 2012). This is likely owing to the social acceptability of alcohol in the Canadian context, the perceived social benefits of alcohol, and the influence of high-user peers can have on other adolescents (Kuntsche et al., 2005; Yarnell et al., 2013). These results are consistent with previous literature that indicates multi-substance use is highly prevalent among Canadian youth and that prevention efforts should address this (Leatherdale et al., 2008; Leatherdale and Ahmed, 2010). It is also noteworthy that < 1 in 5 students reported no substance use by grade 12, clearly highlighting the ongoing need for more effective prevention efforts targeted to high school aged youth. This study identified a mean of 115 min of MVPA per day and 505 min per day of screen time. These estimates are much higher than what has been

identified using objective measures in the Canadian Health Measures Survey (46 min of MVPA and 228 min of sedentary behaviour) (Roberts et al., 2017). Due to the large sample size of the COMPASS survey it was not feasible to obtain objective measures. Self-reported physical activity and screen time measures from the COMPASS study have been validated and shown to be consistent with other self-report surveys (Leatherdale et al., 2014a, 2014b). The COMPASS survey is also not able to identify concurrent screen time and examined older students than the CHMS potentially leading to greater estimates (Roberts et al., 2017). The outcome variables were square root transformed in the analyses to account for the skewed nature of the data.

Consistent with the literature that suggests modifiable risk behaviours co-occur (de la Haye et al., 2014; Leatherdale, 2015), age of first substance use was associated with both MVPA and screen time. Younger age of first use of alcohol was associated with increased MVPA in grade 12. It is hypothesized that this is due to the relationship between team sport participation and alcohol consumption: youth

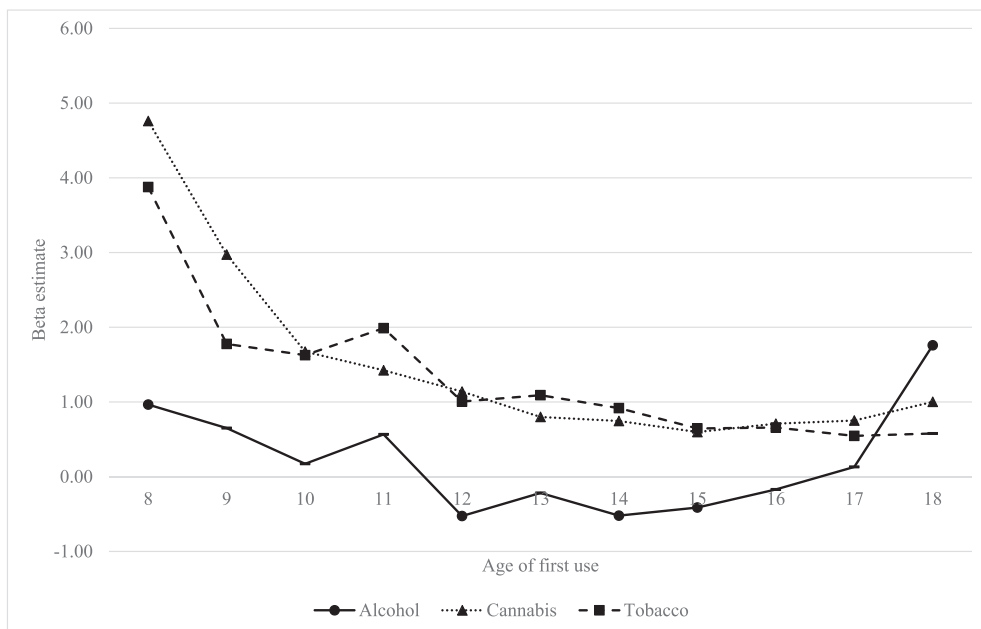


Fig. 3. Plotted beta estimates from the regression models of age of first use of alcohol, cannabis and tobacco on average daily minutes of screen time (square root transformed) of grade 12 students in Canada from years 1 to 5 (2012-2016) of the COMPASS study. All models controlled for sex, ethnicity, weekly spending money, current substance use, and data collection year. The markers have been replaced with a dash (-) at ages that are not significant at $p < 0.05$.

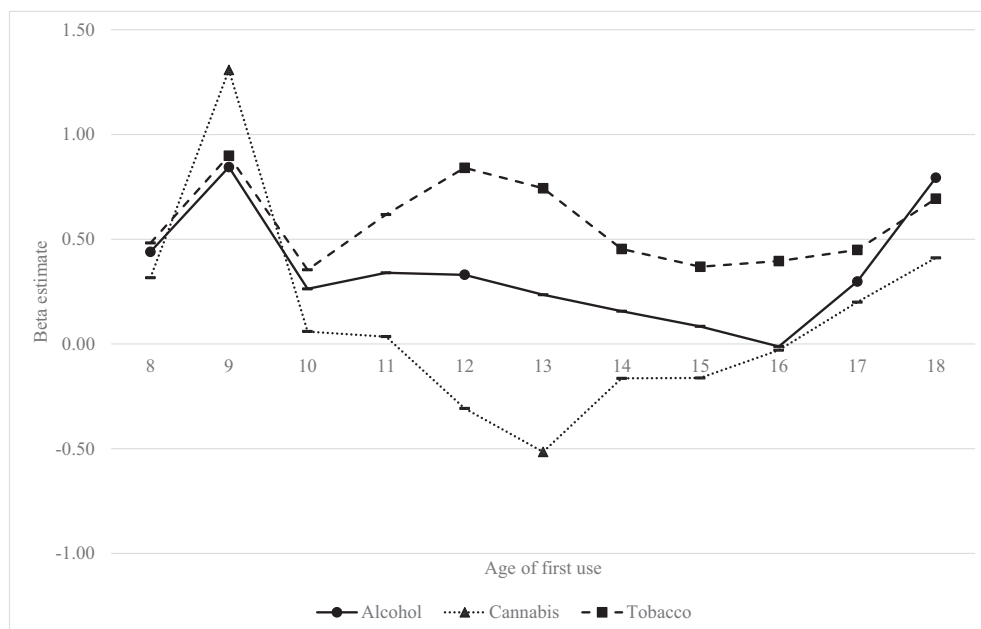


Fig. 4. Plotted beta estimates from the regression models of age of first use of alcohol, cannabis and tobacco on BMI of grade 12 students in Canada from years 1 to 5 (2012-2016) of the COMPASS study. All models controlled for sex, ethnicity, weekly spending money, current substance use, and data collection year. The markers have been replaced with a dash (-) at ages that are not significant at $p < 0.05$.

participation in team sports has been associated with increased alcohol use both in adolescence and young adulthood (Kwan et al., 2014; Lisha and Sussman, 2010). However, this is an effect that may be modified by socioeconomic status, which was not controlled for in this study. There is evidence that lower socioeconomic status is associated with lower levels of physical activity and team sport participation in youth (Pan et al., 2009). No relationship between age of initiation of cannabis and tobacco was seen with MVPA. This is in line with research that suggests that team sport participation appears to be protective against cannabis and smoked tobacco products (Lisha and Sussman, 2010).

Initiating cannabis and tobacco at a younger age was associated with more screen time in grade 12. These results are in line with other findings indicating that screen time clusters with other risk behaviours among youth (Carson et al., 2011; Iannotti et al., 2009). This is in contrast with other research that has examined the relationship between cannabis use and screen time and found null results (Sampasa-Kanyinga et al., 2018; Zuckermann et al., 2019). This is potentially because this literature has dichotomized screen time based on the recommended 2 h limit in the Canadian 24 Hour Movement Guidelines whereas we examined this variable continuously (Tremblay et al., 2016). Most Canadian youth are not meeting this guideline and there is a wide range of screen time among these youth (Roberts et al., 2017). No trend was seen between age of first use of alcohol and screen time. However, initiating alcohol use between ages 12 and 16 was associated with decreased screen time. This is contrary to research studying the opposite relationship which has found links between television and movie watching, media exposure, and alcohol use (Jernigan et al., 2017). It is thought this relationship may be due to youth consuming more alcohol engaging in MVPA and subsequently displacing screen time from their day.

Age of first use of alcohol, cannabis and tobacco were not associated with BMI in grade 12 although tobacco ever users had a higher BMI on average than never users. This is consistent with the literature that links the use of tobacco products with increases in BMI (Green et al., 2018). Despite the fact that age of first use was found to be associated with MVPA and screen time it is not surprising that no consistent trend was seen with BMI. This survey does not collect sufficient information to consider energy intake which is a significant mediator of the relationship between screen time and BMI (Cameron et al., 2016).

4.1. Strengths and limitations

The primary strength of this study was its large sample size. The inclusion of grade 12 students across the first 5 years of COMPASS data collections allowed for the inclusion of almost 40,000 students in the analyses. Due to the self-reported nature of survey data, these results may be subject to social desirability bias, likely leading to the under-reporting of the risk factors studied. However, the use of self-reported measures in this study allowed for the collection of such a large sample. In addition, to encourage participation and honest reporting, a passive consent protocol was used and students were assured their answers would be kept confidential (Thompson-Haile et al., 2013). Despite the breadth of the COMPASS survey, this study lacked data on socioeconomic status and energy intake which may have helped to explain the relationships between age of initiation of substance use and the outcomes of interest. This study also had missing data for 17% of students. Previous work examining these students found that missing students were more likely to be substance users however no differences were found for the main outcomes of interest in this paper (physical activity, screen time, and BMI) (Qian et al., 2015). Students who answered "I don't know" were also more likely to be current drinkers, smokers and cannabis users, and have higher daily MVPA and screen time and BMI. This missing data may suggest a weakened association between age of initiation and the outcomes of interest. Additionally, this study used cross-sectional data and required participants to recall of the age at which they initiated substance use, which could be 10 years ago or more. Cross-sectional research by Golub and colleagues indicates that older students (age 18) were less likely to report alcohol initiation by age 10 than 12 year old students indicating some differential recall by age (Golub et al., 2000). All participants in this study were surveyed at approximately the same age so as long as any potential recall error was also independent of the outcome, recall bias should not be a significant limitation of these results. Additionally, as with any cross-sectional research, reverse causality cannot be ruled out. This study asks students about their MVPA, screen time habits, and BMI in grade 12 and it is unknown what the status of these variables would have been when students initiated substance use. Finally, these results are based on a convenience sample that is not nationally representative, therefore these results may not be representative of all Canadian youth.

5. Conclusions

There are many benefits to delaying substance use among youth. Early substance use is associated with physical and mental health problems, educational underachievement, and subsequent problematic substance use in adulthood. The results of this study indicate that sedentary behaviour prevention efforts may also benefit from delaying early substance use among youth. While no specific cut-off age was identified it appears that for every year tobacco and cannabis use are delayed, there are subsequent benefits to screen time in grade 12. There were no consistent associations between age of initiation and BMI and early initiation of alcohol was associated with increased MVPA.

Declaration of Competing Interest

None to declare.

Acknowledgments

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Appendix A

Table 1

Chi-square comparison of predictor variables comparing students who responded to the questions about age of substance use initiation (Complete Case) compared to those who did not respond or who indicated "I don't know" (Missing/Don't Know).

Variable	Levels	Complete case		Missing/don't know		Chi-Sq
		n	%	n	%	
Sex	Female	17,953	51%	2043	39%	< 0.0001
	Male	17,268	49%	3161	61%	
Data collection year	2012	4906	14%	508	10%	< 0.0001
	2013	8579	24%	1218	23%	
	2014	7539	21%	1152	22%	
	2015	7179	20%	1227	24%	
	2016	7018	20%	1099	21%	
Ethnicity	White	27,898	79%	3740	72%	< 0.0001
	Black	1604	5%	413	8%	
	Asian	2305	7%	381	7%	
	Indigenous	1029	3%	208	4%	
	Latin American/Hispanic	866	2%	152	3%	
	Other/mixed	1519	4%	310	6%	
Weekly spending money	Zero	3876	11%	600	12%	< 0.0001
	\$1 to \$20	5838	17%	802	15%	
	\$21 to \$100	10,787	31%	1417	27%	
	More than \$100	11,277	32%	1664	32%	
	Don't know	3443	10%	721	14%	
Current smoker status	Non-smoker	29,720	84%	4017	77%	< 0.0001
	Current smoker	5501	16%	1187	23%	
Current drinker status	Non-drinker	17,556	50%	2236	43%	< 0.0001
	Current drinker	17,665	50%	2968	57%	
Current marijuana user status	Non-user	27,231	77%	3585	69%	< 0.0001
	Current user	7990	23%	1619	31%	

Table 2

t-Test comparison of outcome variables comparing students who responded to the questions about age of substance use initiation (Complete Case) compared to those who indicated "I don't know" (Don't Know).

Variable	Complete case			Don't know			t-Test
	Mean	SD	Median	Mean	SD	Median	p-Value
Average daily MVPA (minutes)	114.5	87.8	96.4	130.1	103.9	107.1	< 0.0001
BMI	23.1	4.4	22.2	23.3	4.5	22.5	0.0064
Daily screen time (minutes)	505.2	364.3	420.0	590.8	464.4	465.0	< 0.0001

Table 3

Metabolism and Diabetes (INMD) through the "Obesity – Interventions to Prevent or Treat" priority funding awards (OOP-110788; grant awarded to SL), an operating grant from the CIHR Institute of Population and Public Health (IPPH) (MOP-114875; grant awarded to SL), a CIHR Project Grant (PJT-148562; grant awarded to SL), a CIHR Project Grant (PJT-149092; grant awarded to Dr. Karen Patte), and by a research funding arrangement with Health Canada (#1617-HQ-000012; contract awarded to SL). Gillian Williams is funded by the Ontario Graduate Scholarship (OGS).

Author contributions

GW conceptualized and designed the study, drafted the introduction, results, and the discussion of the manuscript, and reviewed and revised the manuscript. KB conceptualized and designed the study, drafted the methods section of the manuscript, carried out all analyses, and reviewed and revised the manuscript. SL conceptualized and designed the study, and critically reviewed the manuscript for important intellectual content. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Regression model of age of first use of alcohol, cannabis and tobacco on average daily minutes of MVPA (square root transformed).

Predictor	Levels	Beta estimate	SE	DF	t Value	p = Pr > t
Intercept		7.69	0.11	105	70.83	< 0.0001
Data collection year	2012 (reference)					
	2013	-0.11	0.08	34,000	-1.38	0.17
	2014	-0.16	0.08	34,000	-2.08	0.04
	2015	-0.16	0.08	34,000	-2.02	0.04
	2016	-0.26	0.08	34,000	-3.21	0.00
Sex	Female (reference)					
	Male	1.26	0.04	34,000	28.32	< 0.0001
Ethnicity	White (reference)					
	Black	0.22	0.11	34,000	2.01	0.04
	Asian	-1.11	0.09	34,000	-11.88	< 0.0001
	Off-reserve aboriginal	0.34	0.14	34,000	2.48	0.01
	Latin American/Hispanic	-0.13	0.14	34,000	-0.88	0.38
	Other/mixed	-0.10	0.11	34,000	-0.91	0.36
Spending money	Zero (reference)					
	\$1 to \$20	0.70	0.08	34,000	8.28	< 0.0001
	\$21 to \$100	1.22	0.08	34,000	15.73	< 0.0001
	More than \$100	1.64	0.08	34,000	21.06	< 0.0001
	Don't know	0.96	0.10	34,000	10.02	< 0.0001
Current drinker	Non-drinker (reference)					
	Current drinker	0.53	0.06	34,000	9.22	< 0.0001
Current cannabis user	Non-user (reference)					
	Current user	0.10	0.07	34,000	1.38	0.17
Current smoker	Non-smoker (reference)					
	Current smoker	-0.15	0.08	34,000	-1.91	0.06
Age of first use - alcohol	8	1.05	0.13	34,000	7.81	< 0.0001
	9	1.43	0.26	34,000	5.49	< 0.0001
	10	0.97	0.18	34,000	5.55	< 0.0001
	11	0.78	0.20	34,000	3.81	0.00
	12	0.55	0.12	34,000	4.42	< 0.0001
	13	0.57	0.11	34,000	5.41	< 0.0001
	14	0.54	0.09	34,000	6.33	< 0.0001
	15	0.51	0.08	34,000	6.32	< 0.0001
	16	0.45	0.08	34,000	5.67	< 0.0001
	17	0.15	0.11	34,000	1.33	0.18
	18	0.15	0.23	34,000	0.64	0.52
Age of first use - cannabis	Never used (reference)					
	8	0.79	0.23	34,000	3.36	0.00
	9	-0.96	0.46	34,000	-2.10	0.04
	10	0.28	0.35	34,000	0.82	0.41
	11	0.81	0.33	34,000	2.47	0.01
	12	0.12	0.20	34,000	0.61	0.54
	13	-0.18	0.14	34,000	-1.26	0.21
	14	-0.26	0.11	34,000	-2.46	0.01
	15	-0.20	0.09	34,000	-2.23	0.03
	16	-0.17	0.08	34,000	-2.02	0.04
	17	-0.15	0.10	34,000	-1.54	0.12
	18	-0.46	0.25	34,000	-1.88	0.06
Age of first use - cigarettes	Never used (reference)					
	8	0.49	0.19	34,000	2.54	0.01
	9	0.22	0.34	34,000	0.64	0.52
	10	0.19	0.28	34,000	0.67	0.50
	11	0.09	0.28	34,000	0.30	0.76
	12	-0.11	0.18	34,000	-0.65	0.52
	13	0.22	0.15	34,000	1.47	0.14
	14	0.16	0.11	34,000	1.41	0.16
	15	0.22	0.10	34,000	2.18	0.03
	16	0.05	0.09	34,000	0.59	0.56
	17	0.27	0.10	34,000	2.64	0.01
	18	1.00	0.25	34,000	3.97	< 0.0001
	Never used (reference)					

Table 4
Regression model of age of first use of alcohol, cannabis and tobacco on average daily minutes of screen time (square root transformed).

Predictor	Levels	Beta estimate	SE	DF	t Value	p = Pr > t
Intercept		20.40	0.19	105	106.69	< 0.0001
Data collection year	2012 (reference)					
	2013	-0.23	0.13	35,000	-1.79	0.07
	2014	-0.13	0.13	35,000	-0.99	0.32
	2015	0.01	0.13	35,000	0.06	0.95

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Table 4 (continued)

Predictor	Levels	Beta estimate	SE	DF	t Value	p = Pr > t	
Sex	2016 Female (reference)	0.01	0.14	35,000	0.10	0.92	
	Male	-0.15	0.08	35,000	-2.05	0.04	
Ethnicity	White (reference)						
	Black	3.08	0.18	35,000	16.71	< 0.0001	
	Asian	0.97	0.16	35,000	6.20	< 0.0001	
	Off-reserve aboriginal	1.66	0.23	35,000	7.21	< 0.0001	
	Latin American/Hispanic	1.97	0.24	35,000	8.19	< 0.0001	
Spending money	Other/mixed	1.44	0.19	35,000	7.76	< 0.0001	
	Zero (reference)						
	\$1 to \$20	-0.18	0.14	35,000	-1.27	0.20	
	\$21 to \$100	-0.46	0.13	35,000	-3.53	0.00	
	More than \$100	-0.69	0.13	35,000	-5.28	< 0.0001	
Current drinker	Don't know	-0.03	0.16	35,000	-0.17	0.86	
	Non-drinker (reference)						
Current cannabis user	Current drinker	0.26	0.10	35,000	2.66	0.01	
	Non-user (reference)						
Current smoker	Current user	0.84	0.12	35,000	7.05	< 0.0001	
	Non-smoker (reference)						
Age of first use - alcohol	Current smoker	0.81	0.13	35,000	6.16	< 0.0001	
	8	0.97	0.23	35,000	4.28	< 0.0001	
	9	0.65	0.44	35,000	1.49	0.14	
	10	0.17	0.30	35,000	0.58	0.56	
	11	0.57	0.34	35,000	1.64	0.10	
	12	-0.53	0.21	35,000	-2.51	0.01	
	13	-0.22	0.18	35,000	-1.23	0.22	
	14	-0.52	0.15	35,000	-3.59	0.00	
	15	-0.41	0.14	35,000	-3.03	0.00	
	16	-0.17	0.13	35,000	-1.27	0.20	
	17	0.13	0.18	35,000	0.71	0.48	
	18	1.76	0.39	35,000	4.50	< 0.0001	
	Age of first use - cannabis	Never used (reference)					
		8	4.76	0.39	35,000	12.08	< 0.0001
		9	2.97	0.77	35,000	3.87	0.00
		10	1.67	0.58	35,000	2.88	0.00
		11	1.42	0.55	35,000	2.59	0.01
		12	1.14	0.34	35,000	3.39	0.00
13		0.80	0.24	35,000	3.32	0.00	
14		0.75	0.18	35,000	4.21	< 0.0001	
15		0.60	0.15	35,000	3.86	0.00	
16		0.71	0.14	35,000	5.11	< 0.0001	
17		0.75	0.17	35,000	4.52	< 0.0001	
18		1.00	0.42	35,000	2.41	0.02	
Age of first use - cigarettes		Never used (reference)					
		8	3.88	0.32	35,000	11.95	< 0.0001
		9	1.78	0.57	35,000	3.10	0.00
		10	1.63	0.47	35,000	3.43	0.00
		11	1.99	0.47	35,000	4.19	< 0.0001
		12	1.01	0.30	35,000	3.40	0.00
	13	1.09	0.25	35,000	4.41	< 0.0001	
	14	0.92	0.19	35,000	4.90	< 0.0001	
	15	0.65	0.17	35,000	3.81	0.00	
	16	0.66	0.15	35,000	4.46	< 0.0001	
	17	0.55	0.17	35,000	3.20	0.00	
	18	0.58	0.43	35,000	1.35	0.18	
		Never used (reference)					

Table 5

Regression model of age of first use of alcohol, cannabis and tobacco on average daily minutes of BMI.

Predictor	Levels	Beta estimate	SE	DF	t Value	p = Pr > t
Intercept		22.22	0.13	104	170.80	< 0.0001
Data collection year	2012 (reference)					
	2013	-0.17	0.09	29,000	-1.97	0.05
	2014	-0.14	0.09	29,000	-1.52	0.13
	2015	0.07	0.09	29,000	0.76	0.44
	2016	-0.07	0.09	29,000	-0.78	0.44
Sex	Female (reference)					
	Male	1.08	0.05	29,000	20.35	< 0.0001
Ethnicity	White (reference)					
	Black	0.32	0.14	29,000	2.33	0.02

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Table 5 (continued)

Predictor	Levels	Beta estimate	SE	DF	t Value	p = Pr > t	
Spending money	Asian	-0.51	0.11	29,000	-4.63	< 0.0001	
	Off-reserve aboriginal	0.80	0.17	29,000	4.83	< 0.0001	
	Latin American/Hispanic	0.34	0.17	29,000	2.00	0.05	
	Other/mixed	0.08	0.13	29,000	0.59	0.56	
	Zero (reference)						
	\$1 to \$20	-0.15	0.10	29,000	-1.50	0.13	
	\$21 to \$100	-0.11	0.09	29,000	-1.16	0.25	
	More than \$100	-0.08	0.09	29,000	-0.86	0.39	
	Don't know	-0.08	0.12	29,000	-0.67	0.50	
	Current drinker	Non-drinker (reference)					
Current cannabis user	Current drinker	-0.12	0.07	29,000	-1.87	0.06	
	Non-user (reference)						
Current smoker	Current user	-0.23	0.08	29,000	-2.81	0.00	
	Non-smoker (reference)						
Age of first use - alcohol	Current smoker	0.17	0.09	29,000	1.84	0.07	
	8	0.44	0.16	29,000	2.78	0.01	
	9	0.84	0.31	29,000	2.72	0.01	
	10	0.26	0.20	29,000	1.28	0.20	
	11	0.34	0.24	29,000	1.41	0.16	
	12	0.33	0.14	29,000	2.30	0.02	
	13	0.23	0.12	29,000	1.92	0.05	
	14	0.16	0.10	29,000	1.55	0.12	
	15	0.08	0.09	29,000	0.88	0.38	
	16	-0.01	0.09	29,000	-0.13	0.90	
	17	0.30	0.13	29,000	2.32	0.02	
	18	0.79	0.28	29,000	2.79	0.01	
	Age of first use - cannabis	Never used (reference)					
		8	0.32	0.32	29,000	1.00	0.32
		9	1.31	0.58	29,000	2.24	0.03
		10	0.06	0.44	29,000	0.14	0.89
		11	0.03	0.39	29,000	0.09	0.93
		12	-0.31	0.23	29,000	-1.32	0.19
		13	-0.52	0.17	29,000	-3.08	0.00
14		-0.16	0.12	29,000	-1.36	0.17	
15		-0.16	0.11	29,000	-1.54	0.12	
16		-0.03	0.09	29,000	-0.32	0.75	
17		0.20	0.11	29,000	1.78	0.07	
18		0.41	0.28	29,000	1.46	0.14	
Age of first use - cigarettes		Never used (reference)					
	8	0.48	0.25	29,000	1.94	0.05	
	9	0.90	0.41	29,000	2.22	0.03	
	10	0.35	0.35	29,000	1.02	0.31	
	11	0.62	0.34	29,000	1.80	0.07	
	12	0.84	0.20	29,000	4.10	< 0.0001	
	13	0.74	0.17	29,000	4.35	< 0.0001	
	14	0.45	0.13	29,000	3.51	0.00	
	15	0.37	0.12	29,000	3.18	0.00	
	16	0.40	0.10	29,000	3.93	< 0.0001	
	17	0.45	0.12	29,000	3.86	0.00	
	18	0.69	0.29	29,000	2.38	0.02	
	Average daily MVPA (in hours)	Never used (reference)	0.02	0.02	29,000	0.99	0.32
Daily screen time (in hours)		0.04	0.00	29,000	8.00	< 0.0001	

Appendix B. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.pmedr.2019.100956>.

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