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

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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., 2010; Huang et al., 2013). 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
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, hierarchal 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
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 use.

### 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 (n = 35,221) | Females (n = 17,953, 51%) | Males (n = 17,268, 49%) | Chi-square p-value |
|---------------------------------|--------|-------------------|---------------------------|-------------------------|--------------------|
| Data collection year            | 2012   | 4906              | 2470                      | 2436                    | 14.1% p = .5291    |
|                                 | 2013   | 8579              | 4338                      | 4241                    | 24.2%              |
|                                 | 2014   | 7539              | 3879                      | 3660                    | 21.6%              |
|                                 | 2015   | 7179              | 3646                      | 3533                    | 20.3%              |
|                                 | 2016   | 7018              | 3620                      | 3398                    | 20.2%              |
| Ethnicity                       | White  | 27,898            | 14,562                    | 13,336                  | 79.2% 78.1%        |
|                                 | Black  | 1604              | 659                       | 945                     | 4.6% 5.7%          |
|                                 | Asian  | 2305              | 1162                      | 1143                    | 6.5% 6.6%          |
|                                 | Indigenous | 1029          | 504                       | 525                     | 2.9% 2.8%          |
|                                 | Latin American/Hispanic | 866 | 404                       | 462                     | 2.5% 2.3%          |
|                                 | Other/mixed | 1519          | 662                       | 857                     | 4.3% 5.0%          |
| Spending money                  | Zero   | 3876              | 1780                      | 2096                    | 11.0% 12.1%        |
|                                 | $1 to $20 | 5838          | 3022                      | 2816                    | 16.6% 16.3%        |
|                                 | $21 to $100 | 10,787         | 6034                      | 4753                    | 30.6% 27.5%        |
|                                 | More than $100 | 11,277        | 5370                      | 5907                    | 32.0% 34.2%        |
|                                 | Don't know | 3443           | 1747                      | 1696                    | 9.8% 9.8%          |
| Current drinker                 | No     | 17,556           | 9458                      | 8098                    | 49.8% 46.9%        |
|                                 | Yes    | 17,665           | 8495                      | 9170                    | 50.2% 53.1%        |
| Current cannabis user           | No     | 27,231           | 14,697                    | 12,534                  | 77.3% 72.6%        |
|                                 | Yes    | 7990             | 3256                      | 4734                    | 22.7% 27.4%        |
| Current smoker                  | No     | 29,720           | 15,715                    | 14,005                  | 84.4% 81.1%        |
|                                 | Yes    | 5501             | 2238                      | 3263                    | 15.6% 18.9%        |
| Age of first use - alcohol      | 8      | 1586             | 456                       | 1130                    | 4.5% 6.5%          |
|                                 | 9      | 271              | 88                        | 183                     | 0.8% 1.1%          |
|                                 | 10     | 645              | 236                       | 409                     | 1.8% 2.4%          |
|                                 | 11     | 461              | 177                       | 284                     | 1.3% 1.6%          |
|                                 | 12     | 1623             | 717                       | 906                     | 4.6% 5.2%          |
|                                 | 13     | 2784             | 1459                      | 1325                    | 7.9% 7.7%          |
|                                 | 14     | 5909             | 3234                      | 2675                    | 16.8% 15.5%        |
|                                 | 15     | 6298             | 3554                      | 2744                    | 17.9% 15.9%        |
|                                 | 16     | 4990             | 2762                      | 2228                    | 14.2% 15.4%        |
|                                 | 17     | 1745             | 904                       | 841                     | 5.0% 4.9%          |
|                                 | 18     | 326              | 148                       | 178                     | 0.9% 1.0%          |
| Never used                      | 8      | 539              | 135                       | 404                     | 1.5% 2.3%          |
|                                 | 9      | 87               | 21                        | 66                      | 0.2% 0.4%          |
|                                 | 10     | 161              | 49                        | 112                     | 0.5% 0.6%          |
|                                 | 11     | 180              | 57                        | 123                     | 0.5% 0.7%          |
|                                 | 12     | 551              | 200                       | 351                     | 1.6% 2.0%          |
|                                 | 13     | 1284             | 564                       | 720                     | 3.6% 4.2%          |
|                                 | 14     | 2851             | 1357                      | 1494                    | 8.1% 8.7%          |
|                                 | 15     | 3619             | 1839                      | 1780                    | 10.3% 10.3%        |
|                                 | 16     | 4084             | 2153                      | 1931                    | 11.6% 11.2%        |
|                                 | 17     | 2139             | 1127                      | 1012                    | 6.1% 5.9%          |
|                                 | 18     | 292              | 131                       | 161                     | 0.8% 0.9%          |
| Never used                      | 8      | 19,434           | 10,520                    | 9114                    | 55.2% 52.8%        |
|                                 | 9      | 154              | 62                        | 92                      | 0.4% 0.5%          |
|                                 | 10     | 237              | 70                        | 167                     | 0.7% 1.0%          |
|                                 | 11     | 236              | 108                       | 128                     | 0.7% 0.7%          |
|                                 | 12     | 691              | 289                       | 402                     | 2.0% 2.3%          |
|                                 | 13     | 1061             | 508                       | 553                     | 3.0% 3.2%          |
|                                 | 14     | 2029             | 987                       | 1042                    | 5.8% 6.0%          |
|                                 | 15     | 2414             | 1191                      | 1223                    | 6.9% 7.1%          |
|                                 | 16     | 3172             | 1608                      | 1564                    | 9.0% 9.1%          |
|                                 | 17     | 2053             | 986                       | 1067                    | 5.7% 6.0%          |
|                                 | 18     | 279              | 111                       | 168                     | 0.8% 0.9%          |
| Never used                      | 8      | 22,749           | 12,027                    | 10,722                  | 63.1% 60.2%        |
(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 (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.

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

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

**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.
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 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., 2009). 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.

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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
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)                  | 1.26          | 0.04| 34,000 | 28.32   | < 0.0001 |
|                           | 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     |
| Never used (reference)    |                                     |               |     |     |         |          |
| Age of first use - cannabis| 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     |
| Never used (reference)    |                                     |               |     |     |         |          |
| Age of first use - cigarettes| 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| |
|-----------|--------|---------------|-----|-----|---------|-----------|
| 2016      | 0.01   | 0.14          | 35,000 | 0.10 | 0.92    |           |
| Sex       | Female (reference) | -0.15 | 0.08 | 35,000 | -2.05 | 0.04    |           |
| Ethnicity | White (reference)  | 3.08  | 0.18 | 35,000 | 16.71 | < 0.0001|           |
|           | Black   | 0.97           | 0.16 | 35,000 | 6.20  | < 0.0001|           |
|           | Asian   | 1.66           | 0.23 | 35,000 | 7.21  | < 0.0001|           |
|           | Off-reserve aboriginal | 1.97  | 0.24 | 35,000 | 8.19  | < 0.0001|           |
|           | Latin American/Hispanic | 1.44  | 0.19 | 35,000 | 7.76  | < 0.0001|           |
| Spending money | Zero (reference)  | -0.18 | 0.14 | 35,000 | -1.27 | 0.20    |           |
|           | $1 to $20 | -0.46           | 0.13 | 35,000 | -3.53 | < 0.0001|           |
|           | $21 to $100 | -0.69          | 0.13 | 35,000 | -5.28 | < 0.0001|           |
|           | Don't know | 0.03           | 0.16 | 35,000 | -0.17 | 0.86    |           |
| Current drinker | Non-drinker (reference) | 0.26 | 0.10 | 35,000 | 2.66  | 0.01    |           |
| Current cannabis user | Non-user (reference) | 0.84  | 0.12 | 35,000 | 7.05  | < 0.0001|           |
| Current smoker | Non-smoker (reference) | 0.81 | 0.13 | 35,000 | 6.16  | < 0.0001|           |
| Age of first use - alcohol | 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           | 0.35 | 35,000 | 2.59  | 0.01    |           |
|           | 12     | 1.14           | 0.34 | 35,000 | 2.39  | 0.02    |           |
|           | 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     | 0.57           | 0.17 | 35,000 | 4.52  | < 0.0001|           |
|           | 18     | 1.76           | 0.39 | 35,000 | 4.50  | < 0.0001|           |
| Age of first use - cannabis | 8 | 3.88 | 0.32 | 35,000 | 11.95 | < 0.0001|           |
|           | 9      | 2.18           | 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  | < 0.0001|           |
|           | 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    |           |
| Age of first use - cigarettes | 8 | 3.88 | 0.32 | 35,000 | 11.95 | < 0.0001|           |
|           | 9      | 2.18           | 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  | < 0.0001|           |
|           | 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    |           |

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) | -0.17 | 0.09 | 29,000 | -1.97 | 0.05    |           |
|           | 2013   | 0.07           | 0.09 | 29,000 | 0.76  | 0.44    |           |
|           | 2014   | 0.07           | 0.09 | 29,000 | -0.78 | 0.44    |           |
|           | 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) | 1.08 | 0.05 | 29,000 | 20.35 | < 0.0001|           |
| Ethnicity | White (reference)  | 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| |
|-------------------------------|------------------------------|---------------|-------|------|---------|----------|
| 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    |
| Spending money                | 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 drinker               | −0.12                        | 0.07          | 29,000| −1.87| 0.06    |
| Current cannabis user         | Non-user (reference)         |               |       |      |         |          |
| Current user                  | −0.23                        | 0.08          | 29,000| −2.81| 0.00    |
| Current smoker                | Non-smoker (reference)       |               |       |      |         |          |
| Age of first use - alcohol    | 8                            | 0.44          | 0.16  | 29,000| 2.78    | 0.01    |
| Age of first use - cannabis   | 8                            | 0.32          | 0.32  | 29,000| 1.00    | 0.32    |
| Age of first use - cigarettes | 8                            | 0.48          | 0.25  | 29,000| 1.94    | 0.05    |
| Average daily MVPA (in hours) | 0.02                         | 0.02          | 29,000| 0.99 | < 0.0001|
| 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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