Trends of poly-substance use among Canadian youth

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ABSTRACT

Introduction: Poly-substance use, increasingly understood as a behaviour with uniquely adverse consequences, is on the rise among Canadian youth. High levels of e-cigarette vaping and the recent legalization of recreational cannabis use may result in an acceleration of this trend. The aim of this work was to characterise changes in youth poly-substance use over time, generate baseline data for future investigations, and highlight areas of interest for policy action.
Methods: Descriptive statistics and regression models explored patterns and trends in concurrent use of multiple substances (alcohol, cigarettes, cannabis, and e-cigarettes) among Canadian high school students taking part in the COMPASS prospective cohort study during Y2 (2013/2014; *n* = 45,298), Y3 (2014/2015, *n* = 42,355), Y4 (2015/2016; *n* = 40,436), Y5 (2016/2017; *n* = 37,060), and Y6 (2017/2018; *n* = 34,879).
Results: Poly-substance use increased significantly over time, with over 50% of students who used substance reporting past-year use of multiple substances by 2017/2018. Male and Indigenous students were significantly more likely to report poly-substance use than female and white students respectively. E-cigarette vaping doubled from Y5 to Y6 and was included in all increasingly prevalent substance use combinations.
Conclusions: Youth poly-substance use, rising since 2012/2013, saw a particularly steep increase after 2016/2017. Differential effects were observed for distinct demographic subpopulations, indicating tailored interventions may be required. E-cigarette vaping surged in parallel with the observed increase, suggesting a key role for this behaviour in shaping youth poly-substance use.

1. Introduction

People who use multiple substances are increasingly seen as a subpopulation exhibiting a unique risk profile, with concerns regarding parallel use superseding interest in the exact sequence of initiation (Biggar, Forsyth, Chen, & Burstein, 2017; Cohn et al., 2018; Connell, Gilreath, & Hansen, 2009; Connor, Gullo, White, & Kelly, 2014; Lopez-Quintero et al., 2018; Moss, Chen, & Yi, 2014). Such substance co-use is associated with risk behaviours and negative health outcomes above and beyond the use of each individual substance in isolation (Connell et al., 2009; Connor et al., 2014; Moss et al., 2014). Youth who co-use substances tend to continue to do so as they age, and transition analyses have found that these adolescents are more likely to take up additional substances than to reduce the number they use over time (Choi, Lu, Schulte, & Temple, 2018; Merrin & Leadbeater, 2018; Merrin, Thompson, & Leadbeater, 2018; Moss et al., 2014). Those who report wide-ranging co-use are also more likely to report poor mental health, high-risk sexual behaviours, and substance use disorders, including

opioid dependence (Arterberry, Horbal, Buu, & Lin, 2016; Fiellin, Tetrault, Becker, Fiellin, & Hoff, 2013), in adulthood, all of which synergistically contribute to negative outcomes and lifelong harm (Andrade, Carroll, & Petry, 2013; Connor et al., 2014; Smith, Farrell, Bunting, Houston, & Shevlin, 2011; Trenz et al., 2013, 2012; White et al., 2013).

Concurrent use of multiple substances is common among adolescents and has been increasing over the past decade, even though use of some substances, primarily alcohol and tobacco, has been decreasing over the same period (Banks, Rowe, Mpofu, & Zapolski, 2017; Choi et al., 2018; Cohn et al., 2018; Font-Mayolas et al., 2013; Morean et al., 2016; White et al., 2013). Canadian data from 2008 indicate that 12% of students in grades 7–12 used multiple substances at that time (Leatherdale & Burkhalter, 2012). Since then, e-cigarettes have emerged as a major new concern in public and youth health, with evidence suggesting that use among youth is on the rise (Government of Canada, 2017, 2018), and that their co-use with other substances is particularly common (Barnett, Soule, Forrest, Porter, & Tomar, 2015;

Giroud et al., 2015; Hammond, Reid, Cole, & Leatherdale, 2017; National Academies of Sciences Engineering and Medicine, 2018; Richter, Pugh, Smith, & Ball, 2017). The recent legalization of cannabis (October 2018) may further increase the risk of youth poly-substance use, even though its use remains illegal for this age group (Ammerman, Ryan, & Adelman, 2015; MacCoun & Reuter, 1997; Palamar, Ompad, & Petkova, 2014; Rusby, Westling, Crowley, & Light, 2018; Stolzenberg, D'Alessio, & Dariano, 2016; Vigil et al., 2018; Wen, Hockenberry, & Cummings, 2015; Williams & Bretteville-Jensen, 2014). Few current policies, programs, or public health initiatives explicitly target youth poly-substance use, despite evidence that their implementation may have beneficial effects (Akbar et al., 2011; Butt, Beirness, Gliksman, Paradis, & Stockwell, 2011; Das, Salam, Arshad, Finkelstein, & Bhutta, 2016; Fischer et al., 2017; Xuan et al., 2015).

This work examined poly-substance use among Canadian youth taking part in COMPASS (2012–2021), a large prospective cohort study of high school student health behaviours (Leatherdale et al., 2014). The five most recent years of COMPASS data (2013/14 to 2017/18) were used to examine trends in this area. The aim of this investigation was to further understand the understudied phenomenon of youth poly-substance use, generate baseline evidence for investigations into the impact of cannabis legalization on this pattern of use, and to highlight areas of interest for future policy action.

2. Materials and methods

2.1. Procedure and participants

COMPASS, a prospective cohort study, annually collects hierarchical data from Canadian grade 9–12 students and the secondary schools they attend (Leatherdale et al., 2014). The COMPASS student questionnaire (Cq) is an anonymous, self-administered questionnaire completed by students during class time. This report uses repeat cross-sectional Cq data from Year 2 (September 2013–June 2014) to Year 6 (September 2017–June 2018). A full description of the COMPASS study methods and data collection tools is available in print (Leatherdale et al., 2014) and online (www.compass.uwaterloo.ca), including technical reports on sampling, recruitment, and retention (Bredin, Thompson-Haile, & Leatherdale, 2015; Reel, Bredin, Battista, & Leatherdale, 2017; Reel, Bredin, & Leatherdale, 2018; Thompson-Haile & Leatherdale, 2013c, 2013b, 2013a; Wagner, Bredin, Thompson-Haile, & Leatherdale, 2015). Data were collected from students attending secondary schools permitting active-information passive-consent protocols in Ontario ($n = 88$) and Alberta ($n = 13$): 45,298 students (89 schools) took part in Year 2 (76% new respondents, 24% returning respondents), 42,355 students (87 schools) in Year 3 (50% new respondents), 40,436 students (81 schools) in Year 4 (49% new respondents), 37,060 students (77 schools) in Year 5 (52% new respondents), and 34,879 students (69 schools) in Year 6 (52% new respondents). Student response rates ranged from 77.5% to 79.9%, with the primary reasons for non-response being absenteeism or scheduled spares at the time of the data collection. The sample of schools changed over time, with some new schools being added and others dropping out of the study. Chi-square tests and Cramer's V were used to determine the significance and magnitude of demographic differences in the sample over time. The sample remains similar over time in terms of distribution of grade, sex, ethnicity, median income and urbanicity. The COMPASS study was approved by the University of Waterloo Office of Research Ethics (OR file 30118) and appropriate school boards.

2.2. Measures

2.2.1. Alcohol

Consistent with national surveillance measures (T. Elton-Marshall et al., 2011), students were asked, "In the last 12 months, how often did you have a drink of alcohol that was more than just a sip?" and

responded with one of ten options: "I have never drunk alcohol", "I did not drink alcohol in the last 12 months", "I have only had a sip of alcohol", "Less than once a month", "Once a month", "2 or 3 times a month", "Once a week", "2 or 3 times a week", "4 to 6 times a week", and "Every day". Students were classified as current drinkers if they reported drinking alcohol at least once a month.

2.2.2. Cigarettes

Consistent with validated national surveillance measures (T. Elton-Marshall, Leatherdale, Manske, et al., 2011; Wong, Shields, Leatherdale, Malaison, & Hammond, 2012), students were asked, "On how many of the last 30 days did you smoke one or more cigarettes?" and responded with one of 8 options: "None", "1 day", grouped options for 2 to 29 days, and "30 days (every day)". Students were classified as current smokers if they reported smoking at least once in the previous 30 days.

2.2.3. E-cigarettes

Students were asked, "In the last 30 days, did you use any of the following?" with response options for different types of tobacco/nicotine products. Students who indicated the option "E-cigarettes" were classed as current e-cigarette users.

2.2.4. Cannabis

Consistent with national surveillance measures (T. Elton-Marshall, Leatherdale, Manske, et al., 2011), students were asked, "In the last 12 months, how often did you use marijuana or cannabis?" and responded with one of 9 options: "I have never used marijuana", "I have used marijuana but not in the last 12 months", "Less than once a month", "Once a month", "2 or 3 times a month", "Once a week", "2 or 3 times a week", "4 to 6 times a week", and "Every day". Students were classified as current users if they reported using cannabis at least once a month.

2.2.5. Poly-substance use

Students were categorized based on the number of substances they reported currently using. For example, single substance users reported the current use of one substance only. Students were defined as being poly-substance users if they were current users of more than one substance.

2.2.6. Demographics

Students were asked to indicate their grade (9–12) and gender (Male/Female). Students were also asked to indicate their ethnicity with response options of "White", "Black", "Asian", "Aboriginal (First Nations, Metis, Inuit)", "Latin American/Hispanic" and "Other". Responses were collapsed into three categories: "White", "Indigenous" and "Other" to ensure adequate sample size in each category.

2.3. Analysis

Statistical analyses were conducted in SAS 9.4. Students with missing values for demographic measures were excluded from this study, resulting in a final sample of 43,312 students in Year 2, 40,597 students in Year 3, 38,591 students in Year 4, 35,288 students in Year 5, and 33,258 students in Year 6. Sample characteristics and substance use trends were examined for the subsample of students indicating use of at least one substance. Chi-square tests were used to examine the significance of observed changes in number and type of substances used. Using the Bonferroni correction, statistical significance was set at 0.0125 to account for multiple comparisons. A multinomial logistic regression model was used to determine the association between study year/sample demographics and the use of two, three and four substances, compared to use of only one substance. Regression was performed using the LOGISTIC procedure with a generalized logit link. Statistical significance was set at $p < 0.05$ for the regression results.

Table 1

Characteristics of high school students currently using at least one of four substances participating in the COMPASS study each year between 2013/2014 and 2017/2018 (ON and AB, Canada).

n (%)	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018
Total	18,736	17,004	15,633	14,356	14,150
Grade					
9	2796 (14.9)	2482 (14.6)	2295 (14.7)	2158 (15.0)	2266 (16.0)
10	4560 (24.3)	4422 (26.0)	3733 (23.9)	3807 (26.5)	3553 (25.1)
11	5528 (29.5)	5132 (30.2)	4768 (30.5)	4234 (29.5)	4342 (30.7)
12	5852 (31.2)	4968 (29.2)	4837 (30.9)	4157 (29.0)	3989 (28.2)
Gender					
Female	8678 (46.3)	7847 (46.1)	7063 (45.2)	6622 (46.1)	6598 (46.6)
Male	10,058 (53.7)	9157 (53.9)	8570 (54.8)	7734 (53.9)	7552 (53.4)
Race/ethnicity					
White	15,326 (81.8)	13,662 (80.3)	12,434 (79.5)	11,459 (79.8)	11,201 (79.2)
Indigenous	925 (4.9)	817 (4.8)	674 (4.3)	757 (5.3)	716 (5.1)
Other	2485 (13.3)	2525 (14.8)	2525 (16.2)	2140 (14.9)	2233 (15.8)
Cigarette smoker					
Yes	5002 (26.7)	4537 (26.7)	4459 (28.5)	4085 (28.5)	3657 (25.8)
No	13,734 (73.3)	12,467 (73.3)	11,174 (71.5)	10,271 (71.5)	10,493 (74.2)
E-cigarette vaper					
Yes	3427 (18.3)	4287 (25.2)	3915 (25.0)	3754 (26.1)	6199 (43.8)
No	15,309 (81.7)	12,717 (74.8)	11,718 (75.0)	10,602 (73.9)	7951 (56.2)
Alcohol drinker					
Yes	16,222 (86.6)	14,505 (85.3)	13,301 (85.1)	12,121 (84.4)	11,169 (78.9)
No	2514 (13.4)	2499 (14.7)	2332 (14.9)	2235 (15.6)	2981 (21.1)
Cannabis user					
Yes	7178 (38.3)	6719 (39.5)	6227 (39.8)	5803 (40.4)	5737 (40.5)
No	11,558 (61.7)	10,285 (60.5)	9406 (60.2)	8553 (59.6)	8413 (59.5)
Number of substances used					
1	10,500 (56.0)	9060 (53.3)	8239 (52.7)	7438 (51.8)	6504 (46.0)
2	4471 (23.9)	4146 (24.4)	3809 (24.4)	3591 (25.0)	3973 (28.1)
3	2673 (14.3)	2496 (14.7)	2295 (14.7)	2165 (15.1)	2380 (16.8)
4	1092 (5.8)	1302 (7.7)	1290 (8.3)	1162 (8.1)	1293 (9.1)

Additionally, multinomial logistic regression models were run on each demographic subgroup with year as a categorical predictor in order to determine the significance of the patterns shown in the graphs. These results are included as a Supplementary Table 1 in the appendix.

3. Results

3.1. Sample characteristics

Students who reported using at least one of the four substances investigated (alcohol, cigarettes, e-cigarettes, cannabis) were included in the sample (Table 1). Of these, a slightly larger percentage was male, and most were white. Among those who used substances, the proportion of students reporting alcohol drinking decreased by 7.7% between 2013/2014 and 2017/2018, with cigarette smoking also decreasing in 2017/2018 following a slight increase in the two previous years. Cannabis use increased slightly, from 38.3% in 2013/2014 to 40.5% in 2017/2018. The most noticeable change observed was in e-cigarette vaping, which rose from 26.1% in 2016/2017 to 43.8% in 2017/2018. Non-use remained approximately steady (58.5% average) over the years examined though a slight decrease (1.5%) was observed in 2017/2018 (data not shown).

3.2. Co-use combinations among students using multiple substances

From 2013/2014 to 2016/2017, the most common combination of substances among those using two substances was current alcohol and cannabis use (Fig. 1). However, in 2017/2018 it was overtaken by alcohol use with e-cigarette vaping, which had doubled in prevalence from the previous year. Cigarette smoking with vaping and cigarette smoking with cannabis use declined over the same period, while a slight increase in vaping with cannabis use was observed (1.19%, $p < 0.0001$). All tri-use combinations except cigarette smoking with alcohol and cannabis use increased between 2015/2016 and 2017/

2018 ($p < 0.001$ in all cases), with the rise in vaping with alcohol use and cannabis use most pronounced and this behaviour most common in 2017/2018. Co-use of all four substances rose from just under 6% in 2013/2014 to just over 9% in 2017/2018 ($p < 0.0001$).

3.3. Poly-substance use among demographic subgroups

Male students were more likely to report poly-substance use at all levels until 2017/2018, when a higher proportion of female students reported dual-substance use for the first time (Fig. 2). Single substance use decreased rapidly among both genders, from 60% in 2013 to 49% in 2017 for females ($p < 0.0001$) and from 52% to 43% for males ($p < 0.0001$). Approximately parallel increases were observed in the proportion of quad-substance users, from 4% in 2013 to 6% in 2017 for females ($p < 0.0001$) and from 7% to 11% for males ($p < 0.0001$). Tri-substance use started to rise a year earlier in female than in male students, which led to a narrowing of the percentage gap between the two groups in this category.

White students were least likely to report quad-substance use at all time points and most likely to report single substance use until 2016/2017 (Fig. 3). Among Indigenous students, single substance use decreased by almost 10% from 2016/2017 to 2017/2018 ($p = 0.0070$), and while dual and tri-use remained approximately steady, quad-substance use increased in the same time period (6.1%, $p < 0.0001$) after a prior decrease. Rates of Indigenous students reporting quad-substance were the highest observed in 2017/2018. Students grouped into the 'Other' category reported decreasing rates of tri- and quad-substance use and increasing rates of single and dual use over time.

Single substance use rates dropped between 2013/2014 and 2017/2018 in all grades investigated in this study ($p < 0.001$ in all cases; Fig. 4A). Poly-use increased for most grades, on average, with a particularly noticeable increase in dual substance use among students in grade 9 (4.9%, $p < 0.0001$) and in quad-substance use for students in grade 12 (5.2%, $p < 0.0001$). Rates of tri-substance use were
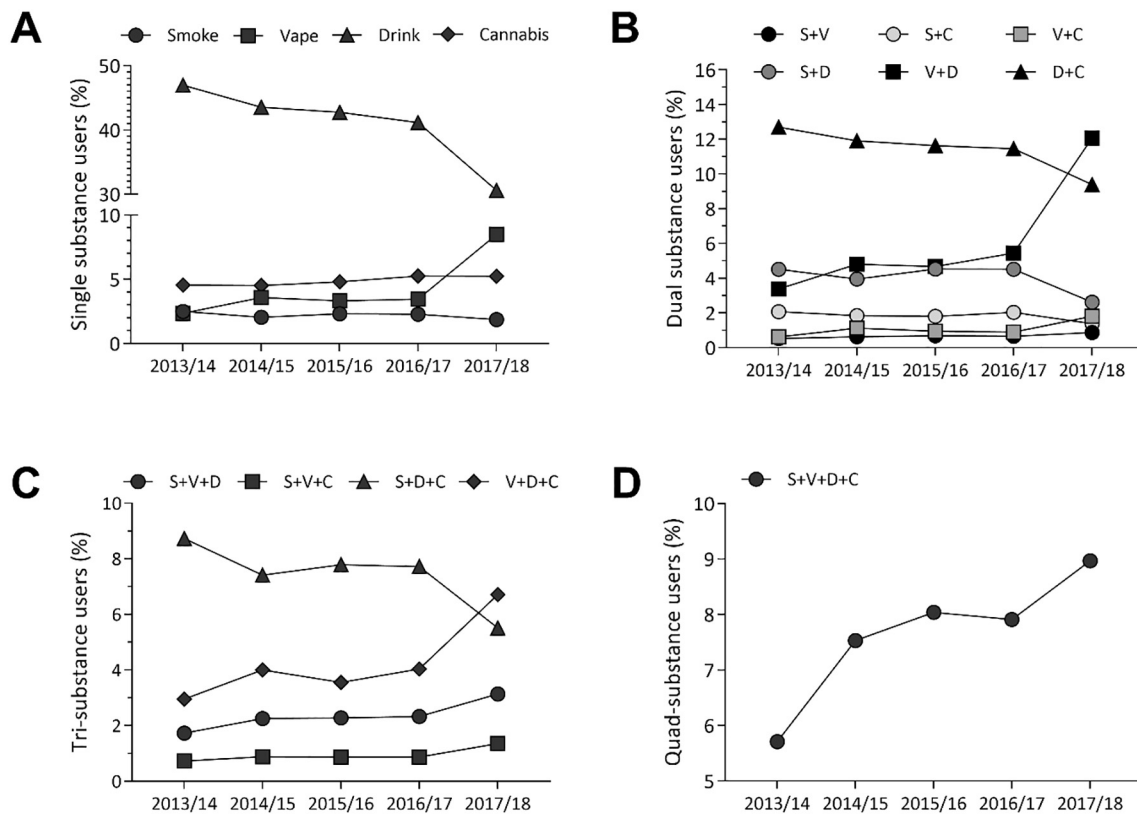
Fig. 1. Substance prevalence in single and co-using behaviour among substance-using youth participating in the COMPASS study (ON and AB, Canada). Rate of substance-using high school students who report using (A) one of four substances in isolation, (B) a given combination of two substance, (C) a given combination of three substances, or (D) all four substances from 2013/2014 to 2017/2018. S…smoking (cigarettes), V…vaping (E-cigarettes), D…drinking (alcohol), C…Cannabis. Year label on x-axis indicates the start of the respective school year in which data were collected. Axes adjusted for visibility.

particularly low for grade 9 students, for whom prevalence of dual and quad-poly-use in general clustered closer with students in other grades. This youngest group of students also reported the only, though non-significant, decrease in quad-substance use between 2015/2016 and 2017/2018 (1.0%, $p = 0.2302$).

Regression analysis indicated that odds of poly-substance use significantly rose after the baseline year (2013/2014), with effect size increasing for each additional time point, particularly for quad-substance use (Table 2). Male students had higher odds of reporting poly-substance use, a disparity which increased with each additional substance used, with almost double the odds of female students of using four substances (compared to using only one). Odds of poly-substance use also increased with increasing grade. Finally, non-white students reported increased odds of using multiple substances compared to white students, with those for Indigenous students particularly high.

4. Discussion

All three levels of poly-substance use examined in this work (co-use of two, three, or four substances respectively) significantly increased among substance using high school students over time, with the rise in quad-substance use particularly steep. By 2017/2018, over 50% of substance users were using more than one substance and reports of single substance use had dropped accordingly. Lack of data makes a direct comparison with other national or international results impossible, but historical estimates range from 20% (Australia, 2007) to 34% (U.S.A., 2008) for poly-use and 31% for cannabis/alcohol co-use alone (Québec, Canada, 2008) (Brière, Fallu, Descheneaux, & Janosz, 2011; Moss et al., 2014; White et al., 2013). Together, these results suggest that poly-use is on the rise among substance-using youth, and as peer influence plays an outsize role in determining adolescent

engagement with both legal and illegal substances (Biggar et al., 2017; Brière et al., 2011; Connell, Gilreath, Aklin, & Brex, 2010; White et al., 2013), this trend may continue or accelerate without intervention.

Several demographic differences between students using single and those using multiple substances were observed. Poly-substance use increased across all grades examined, except for quad-substance use, which continuously decreased among grade 9 students starting in 2015/2016. Nevertheless, rising prevalence of dual and tri-substance use reported by the youngest participants is concerning, as early poly-substance use is strongly associated with subsequent use disorders and related health issues (Moss et al., 2014; Trenz et al., 2012). Averaged over time, male students had significantly higher odds of engaging in poly-substance use, a result in line with some previous evidence (Leatherdale & Burkhalter, 2012; Patrick et al., 2018), though not all (Merrin et al., 2018; White et al., 2013). However, female students reported more dual substance use in 2017/2018 for the first time, suggesting that they may be catching up. It is also possible that male students are shifting to higher levels of poly-use, but the narrowing gender gap in tri-substance use does not support this conclusion. Concerningly, some evidence of a 'telescoping effect', i.e. more rapid progression through usage milestones, has been observed among female adolescents (Lewis, Hoffman, & Nixon, 2014). In combination with the results presented here this suggests that gender-specific trend monitoring may be required. Finally, Indigenous students, previously reported to be at increased risk for concurrent substance use (Canadian Centre on Substance Abuse, 2007), were significantly more likely than white students to use multiple substances, and in 2017/2018 reported the highest prevalence of quad-substance use among all ethnicity/race groups for the first time. With existing evidence that illegal and prescription drug use is particularly prevalent among Indigenous peoples (Currie, Wild, Schopflocher, Laing, & Veugelers, 2013; Tara Elton-
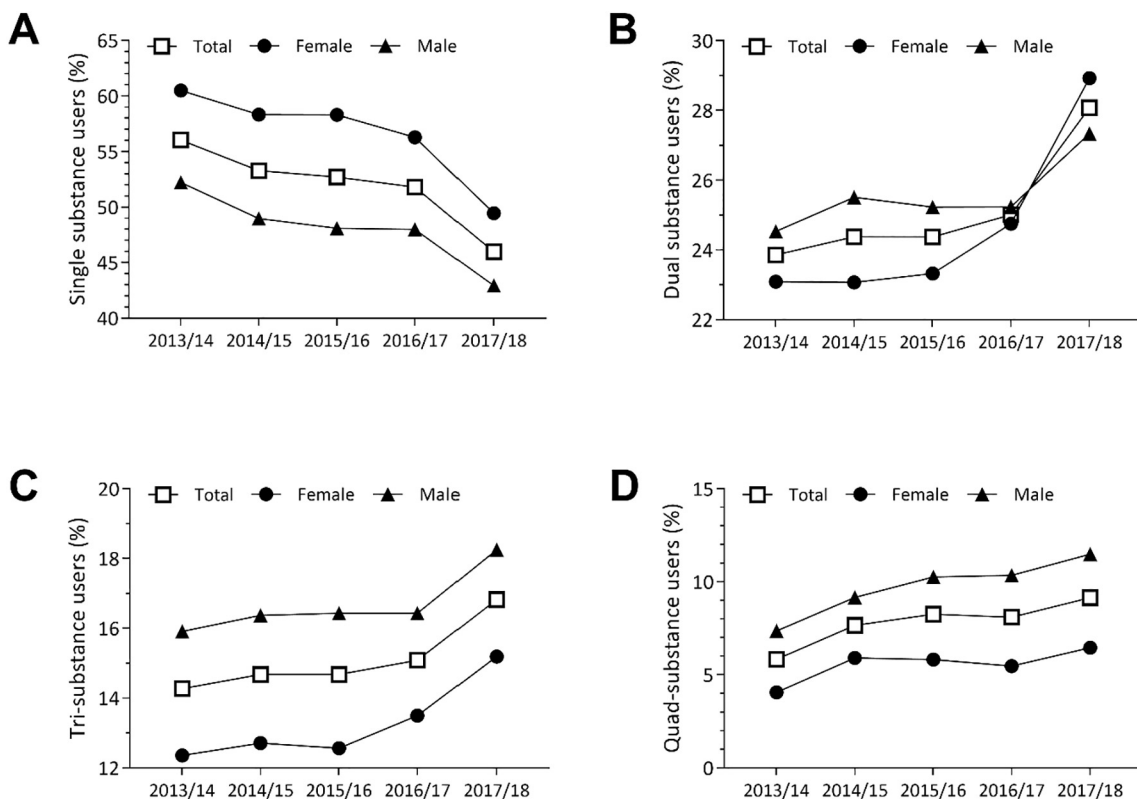
Fig. 2. Prevalence of single and poly-use among substance-using youth participating in the COMPASS study overall and by gender (ON and AB, Canada). Rates of (A) single substance, (B) dual substance, (C) tri-substance, and (D) quad-substance use from 2013/2014 to 2017/2018. Year label on x-axis indicates the start of the respective school year in which data were collected. Axes adjusted for visibility.
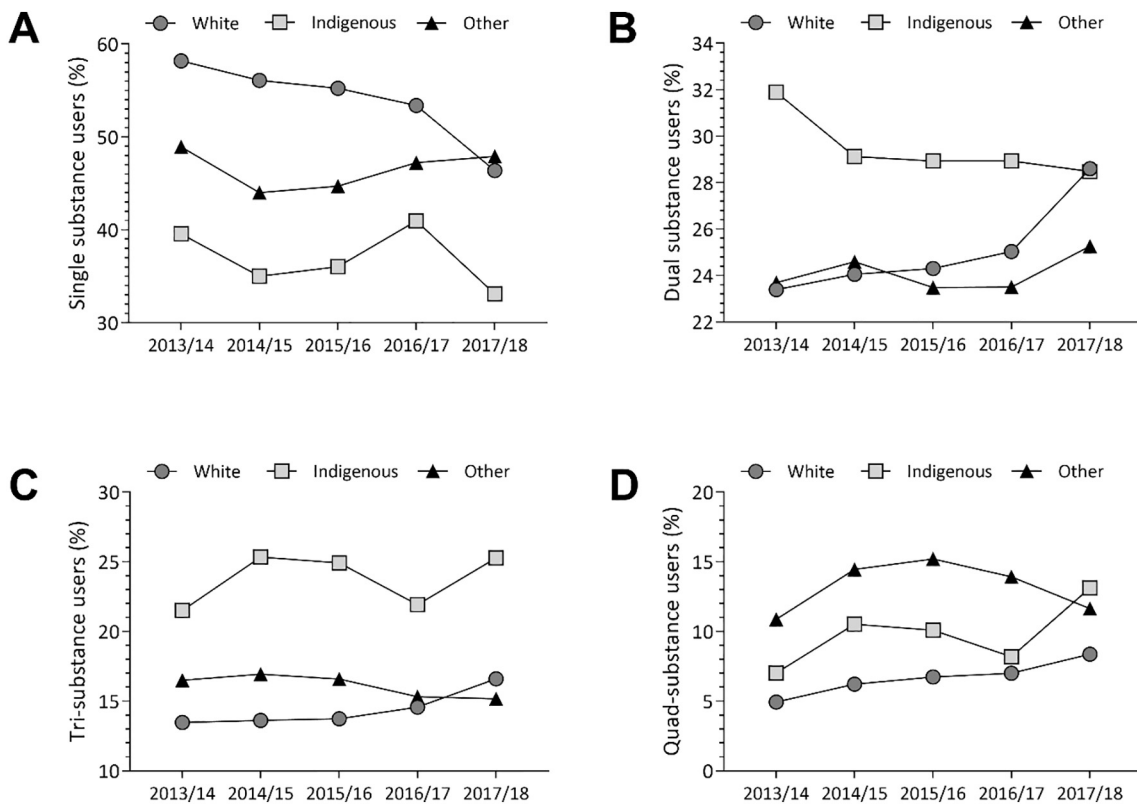

Fig. 3. Prevalence of single and poly-use among substance-using youth participating in the COMPASS study by race/ethnicity (ON and AB, Canada). Rates of (A) single substance, (B) dual substance, (C) tri-substance, and (D) quad-substance use from 2013/2014 to 2017/2018. Year label on x-axis indicates the start of the respective school year in which data were collected. Axes adjusted for visibility.
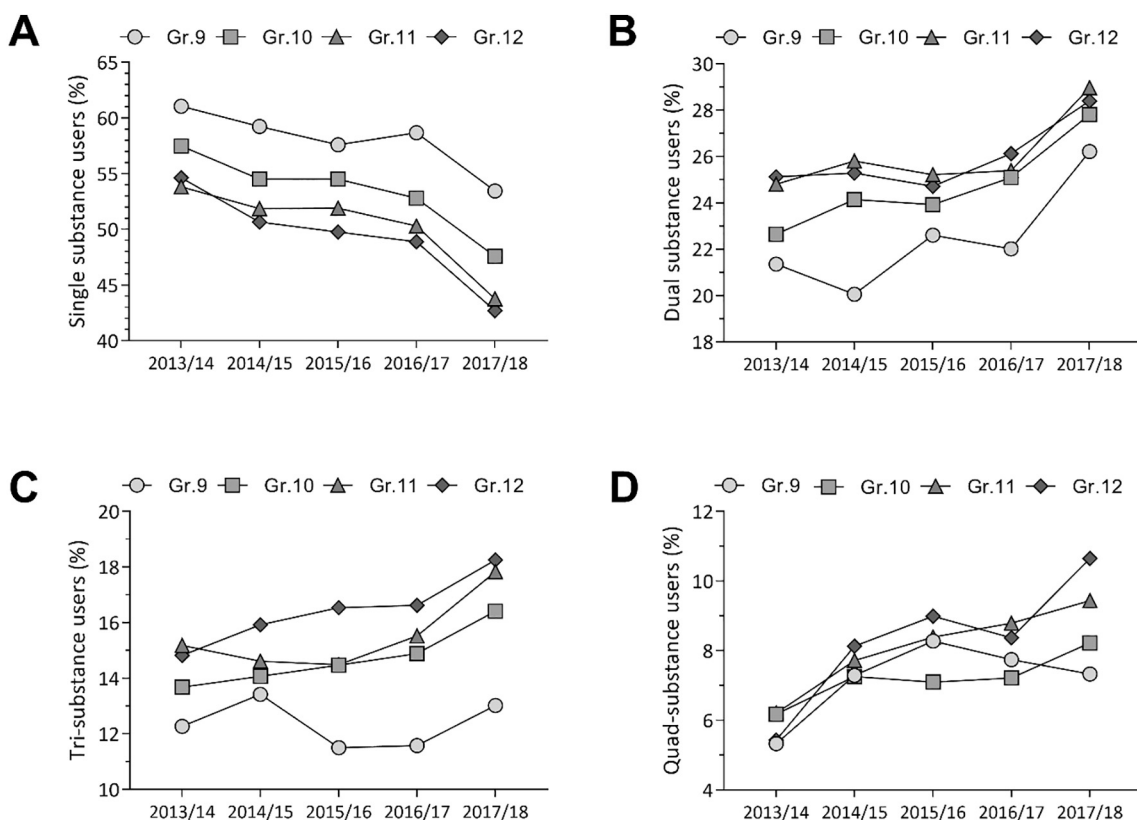
Fig. 4. Prevalence of single and poly-use among substance-using youth participating in the COMPASS study by grade (ON and AB, Canada). Rates of (A) single substance, (B) dual substance, (C) tri-substance, and (D) quad-substance use from 2013/2014 to 2017/2018. Year label on x-axis indicates the start of the respective school year in which data were collected. Axes adjusted for visibility.

Table 2

Regression analysis of substance poly-use (vs single use) for high school students currently using at least one of four substances participating in the COMPASS study each year between 2013/2014 and 2017/2018 (ON and AB, Canada). Models were adjusted for year, gender, grade and race/ethnicity.

OR (95% CI)	2 vs 1	3 vs 1	4 vs 1
Year			
2013/2014 (*ref*)			
2014/2015	1.08 (1.02, 1.13)*	1.08 (1.02, 1.15)*	1.37 (1.26, 1.49)*
2015/2016	1.09 (1.03, 1.14)*	1.09 (1.03, 1.16)*	1.47 (1.35, 1.60)*
2016/2017	1.14 (1.08, 1.20)*	1.15 (1.08, 1.22)*	1.50 (1.38, 1.64)*
2017/2018	1.45 (1.38, 1.53)*	1.46 (1.37, 1.56)*	1.94 (1.78, 2.11)*
Gender			
Female (*ref*)			
Male	1.23 (1.19, 1.27)*	1.48 (1.42, 1.55)*	1.98 (1.87, 2.09)*
Grade			
9 (*ref*)			
10	1.22 (1.15, 1.29)*	1.33 (1.24, 1.42)*	1.15 (1.05, 1.26)*
11	1.37 (1.30, 1.45)*	1.50 (1.41, 1.61)*	1.37 (1.25, 1.49)*
12	1.40 (1.32, 1.48)*	1.63 (1.52, 1.74)*	1.42 (1.30, 1.55)*
Race/ethnicity			
White (*ref*)			
Indigenous	1.79 (1.66, 1.94)*	2.54 (2.33, 2.77)*	2.26 (2.01, 2.55)*
Other	1.10 (1.05, 1.16)*	1.27 (1.20, 1.34)*	2.21 (2.07, 2.36)*

* Indicates $p < 0.05$.

Marshall, Leatherdale, & Burkhalter, 2011), targeted support is likely to be needed to prevent the escalation of poly-use and subsequent harms to youth health.

The emergence of e-cigarette vaping, mono-use of which doubled from 2016/2017 to 2017/2018, appears to have had a key role in increasing poly-substance use in this sample. All dual and triple substance combinations including this behaviour rose in prevalence towards the end of the examined period, with concurrent vaping and drinking particularly common. The association between e-cigarettes and alcohol, previously observed in other studies (Morean et al., 2016; Schlienz & Lee, 2018; Taylor et al., 2017), together with data on social media trends (Camenga et al., 2018; Chu et al., 2018; Sampasa-Kanyinga & Hamilton, 2018), indicates that use of the former is now a social activity (Pepper et al., 2017; Yule & Tinson, 2017). This is particularly concerning not only in light of potential feedback effects due to the previously discussed outsize effects of peer behaviour, but also because e-cigarette use has been shown to increase the risk of cigarette smoking (Barnett et al., 2015; Bold et al., 2018; Hammond et al., 2017), which also often co-occurs with alcohol use in social situations (Berg et al., 2018; Gubner, Thrul, Kelly, & Ramo, 2018; Silveira et al., 2018), adding an additional layer of risk. Concerningly, early initiation of cigarette and alcohol co-use may increase the likelihood of opioid use (Arterberry et al., 2016), and the possibility that vaping may come to replace smoking in this role cannot yet be discounted.

The poly-use impact of cannabis, the other substance for which reports of mono-use rose over time, was mixed, with increases only observed for dual and triple substance use combinations which also included e-cigarette vaping. However, concerns regarding the impact of cannabis legalization on poly-substance use remain. This is because there may be a positive feedback loop between e-cigarette and cannabis use, partially due to cannabis vaping (which may increase following legalization) (Borodovsky et al., 2017; Borodovsky, Crosier, Lee, Sargent, & Budney, 2016; Schlienz & Lee, 2018), and partially because each behaviour has been shown to be a risk factor for the other (Audrain-McGovern, Stone, Barrington-Trimis, Unger, & Leventhal, 2018; Dai, Catley, Richter, Goggin, & Ellerbeck, 2018; Giroud et al., 2015; Peters, Bae, Barrington-Trimis, Jarvis, & Leventhal, 2018). Also, higher vaping prevalence has been shown to be associated with time elapsed since legalization (Borodovsky et al., 2017), suggesting that prevention and intervention activities targeted to mitigating associated

risks of poly-use will be required long-term. These issues arise independently from and in addition to other direct and indirect putative effects of cannabis legalization, i.e. increases in youth cannabis use which in turn may drive experimentation with other substances, on youth poly-substance use (Ammerman et al., 2015; Cerdá et al., 2018; MacCoun & Reuter, 1997; Palamar et al., 2014; Rusby et al., 2018; Stolzenberg et al., 2016; Vigil et al., 2018; Wang, Hipp, Butts, & Lakon, 2018; Weinberger, Platt, Copeland, & Goodwin, 2018; Wen et al., 2015; Williams & Bretteville-Jensen, 2014). Even if cannabis legalization were not itself to drive increased use, the potential for detrimental interactions between higher vaping rates and widely available THC-containing products may be substantial.

4.1. Strengths and limitations

COMPASS benefits from several strengths, such as a questionnaire based on national surveillance tools, multiple years of data, and a large sample size (Leatherdale et al., 2014). However, some limitations should be considered when interpreting the results presented here. Data from self-report questionnaires may be subject to recall and social desirability biases, which may result in underreporting of substance use. Additionally, substance use has consistently been linked to school absenteeism and drop-out (Ripamonti, 2017), which may also lead to underestimations, especially as level of poly-use increases. This work did not distinguish simultaneous use ('true' co-use) from contemporary use occurring separately (e.g., sequentially) within the same time period, and therefore may overestimate the prevalence of poly-use by misclassifying such cases. The annual data selected for this work do not stem from an identical sample of students, so changes in sample composition may have influenced the prevalence rates observed. As a mitigation measure, we confirmed that there were no meaningful differences in the demographic distribution of the sample over time. Students who completed the survey in multiple years may have retained some prior knowledge of study questions, which could result in conditioning bias only among those who have previously completed the survey. However, time between data collections (12 months) and size of the survey (72 questions) will likely have limited such an effect, which is likely to be minimal compared to the effects of substance use on participation and the other biases associated with self-report measures discussed above. Finally, schools participating in COMPASS form a convenience sample with some participation drop-off and results are therefore not generalizable. However, high participation rates within schools were ensured with a passive-consent protocol, reducing student selection bias and the large size of the sample suggests that conclusions drawn will nevertheless be relevant to a substantial proportion of substance-using Canadian high school students.

5. Conclusions

The data presented here suggest that youth poly-substance use has been on the rise among substance-using high school students since 2013/2014, with a particularly steep increase observed after 2016/2017. Differential effects were observed for distinct demographic sub-populations, with male and Indigenous students significantly more likely to engage in substance co-use. Finally, e-cigarette vaping surged in parallel with the observed increase, suggesting a key role for this behaviour in shaping youth poly-substance use.

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Declaration of Competing Interest

None declared.

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