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Original quantitative research

Substance use classes and symptoms of anxiety and depression among Canadian secondary school students

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Abstract

Introduction: Few studies have assessed patterns of substance use among Canadian adolescents. This cross-sectional study examined substance use classes among Canadian secondary school students and associations with anxiety and depression.

Methods: This study used data from Year 6 (2017/18) of the COMPASS study. Students (n = 51 767) reported their substance use (alcohol, cannabis, cigarette and e-cigarette use) and anxiety and depression symptoms. We employed latent class analysis to identify substance use classes and multinomial logistic regression to examine how anxiety and depression were associated with class membership.

Results: Overall, 40% of students indicated having anxiety and/or depression (50% in females; 29% in males) and 60% of students reported substance use (60% in females; 61% in males). We identified three substance use classes: *poly-use*, *dual use*, and *non-use*. Females with both anxiety and depression had the highest odds of being in the poly-use class compared to the non-use class (odds ratio [OR] = 4.09; 95% confidence interval [CI]: 3.59–4.65) followed by females with depression only (OR = 2.65; 95% CI: 2.31–3.04) and males with both anxiety and depression (OR = 2.48; 95% CI: 2.19–2.80). Symptomatology was also associated with belonging to the dual use class except among males with anxiety only (OR = 1.13; 95% CI: 0.94–1.37).

Conclusion: Canadian secondary school students are engaging in dual and poly-substance use, and anxiety and depression were associated with such use. Females had a higher prevalence of anxiety and depression and should be a priority population for mental health programming.

Keywords: *anxiety, depression, alcohol drinking, cannabis smoking, cigarette smoking, vaping, latent class analyses, adolescent*

Highlights

- 40% of students indicated anxiety and/or depression and 60% of students reported substance use.
- Females had a higher prevalence of anxiety and/or depression (50% vs. 29%).
- Overall, anxiety and/or depression were associated with dual use and poly-substance use.
- Females with both anxiety and depression had the highest odds of being in the poly-substance use class.

Introduction

In 2017, 57% of Canadians aged 15 to 19 years reported alcohol use, 19% reported cannabis use, 8% reported cigarette smoking and 23% reported trying e-cigarettes.[1] Such use is associated with adverse mental, physical and academic outcomes.[2,3] Notably, recent evidence shows an estimated 23% of Canadian students in Grades 9 to 12 use more than one substance, also known as poly-substance use or poly-use.[4]

While the prevalence of substance non-use has remained steady among high school students over the past five years, poly-use is increasing among adolescents, likely due to the emergence of e-cigarettes.[5] A recent systematic review identified strong evidence for the presence of subgroups of adolescent substance use, with common clusters being low use, single- or dual-substance use, moderate general multi-use and high multi-use.[6] Unfortunately, there is limited research examining patterns of substance use among Canadian adolescents and how e-cigarette use fits in.[6-9] This is concerning, as poly-use is associated with higher risks of negative social and health consequences.[10,11]

Age has been consistently identified as a risk factor for poly-substance use.[6,12] The relationship between sex and poly-substance use is more nuanced. Most studies found males more likely to be in higher use categories,[4,5,9,13-18] but others have found no difference[19-22] or increased risk for females in certain poly-use classes,[23,24] or different latent classes.[25] Other individual-level factors associated with poly-substance use include lower socioeconomic status, early-onset substance use, low social connectedness and parental and peer substance use.[6,12,16,24,26-34]

Substance use has also been associated with adolescent anxiety and depression.[35,36] This is a common problem among adolescents: one-third of Ontario high school students report moderate-to-severe symptoms

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of anxiety and/or depression.[37] Generally, those who report poly-use have higher instances of poor mental health, including anxiety and depression.[11,38-40] However, one study identified protective effects of internalizing problems (which is a measure capturing anxiety, depression and somatic symptoms) on poly-use class membership among adolescents.[24]

Most of the work examining poly-use and poor mental health among adolescents has focussed on depression. However, there is a high prevalence of comorbidity, with an estimated 25% to 50% of youth with depression also meeting the criteria for an anxiety disorder.[41] These youth have a higher risk of longer duration of symptoms, greater impairment, recurrence and greater utilization of mental health services.[41] Therefore, it is important to consider both depression and anxiety simultaneously in analyses.

In the context of the limitations in the current knowledge base, our objectives were to determine the substance use classes among Canadian secondary school students and examine their cross-sectional associations with anxiety and depression symptoms.

Methods

Design

The COMPASS study is a prospective cohort study in Canada that annually collects data from students in Grades 9 to 12 in British Columbia, Alberta and Ontario, and Secondary I to V in Quebec (the equivalent of Grades 7 to 11). Students in Grades 7 and 8 equivalent or with no assigned grade were categorized as "other." To examine cross-sectional patterns of substance use, this study used student questionnaire data from Year 6 (Y6: 2017/18) of the COMPASS study from 122 schools in British Columbia (n = 16), Alberta (n = 8), Ontario (n = 61), and Quebec (n = 37). Schools were purposively sampled based on permitted use of passive consent protocols.[42] A full description of the COMPASS study can be found online (https://uwaterloo.ca/compass-system/) or in print.[43]

Participants

A total of 66434 students participated in Y6 of the COMPASS study. Student response rate was 81.8% and the primary reason for non-response was being absent at the time of data collection. Among respondents, 51767 had complete data (complete information for covariates and at least one substance use measure) and were included in the final sample. There were no significant differences in chi-square tests comparing those included and excluded based on missing outcome data (data available upon request).

Measures

Substance use

Students were asked to report *alcohol use* ("In the last 12 months, how often did you have a drink of alcohol that was more than just a sip?"); *cannabis use* ("In the last 12 months, how often did you use marijuana or cannabis? [a joint, pot, weed, hash]"); *cigarette use* ("Have you ever tried cigarette smoking, even just a few puffs?" and "On how many of the last 30 days did you smoke one or more cigarettes?"); and *e-cigarette use* ("Have you ever tried an electronic cigarette, also known as an e-cigarette?" and "On how many of the last 30 days did you use an e-cigarette?"). It should be noted that these measures are not equivalent to problematic substance use and should not be interpreted as such.

Anxiety

The *Generalized Anxiety Disorder 7* (GAD-7) scale[44] was used to assess generalized *anxiety symptoms*. The GAD-7 reports on self-perceived feelings of worry, fear and irritability over a two-week period. Students were asked how often they were bothered by each symptom with the following response options: "Not at all," "Several days," "Over half the days" or "Nearly every day." The GAD-7 has been found to be reliable among adolescents (α = 0.91)[45] and in the current study had an alpha coefficient of 0.91 for females and 0.90 for males. When screening for anxiety disorders, a score of 10 is used as a recommended cut point for further evaluation and was used to categorize students as having clinically relevant anxiety symptomatology (herein "anxiety").[44]

Depression

The *Center for Epidemiological Studies Depression Scale* (CES-D-10)[46,47] was used to assess *depression symptoms*. Items assess characteristics of clinical depression, including negative affect, anhedonia and somatic symptoms, such as "I felt everything I did was an effort," or "I could not get 'going.'" Students were asked how often they experienced each symptom within the last 7 days, with the following response options: "None or less than 1 day," "1–2 days," "3–4 days," or "5–7 days." The CES-D-10 has been found to be reliable among adolescents (α = 0.85)[46] and in the current study had an alpha coefficient of 0.74 for females and 0.78 for males. A score of 10 or higher is indicative of clinically relevant depression symptomatology (herein "depression").[46]

Covariates

Poly-substance use is associated with other risky behaviour[11,48-51] as well as family and friend support.[4] *Truancy* was used as a measure of student risky behaviour. Students were asked, "In the last 4 weeks, how many classes did you skip when you were not supposed to?" Students who reported any number of classes skipped were categorized as truant. To ascertain whether students felt they had *family* or *friend support*, they were asked how much they agreed with the statement "I can talk about my problems with my family/friends." Students who selected "Agree" or "Strongly agree" were categorized as having family or friend support.

Consistent with other adolescent health research,[52] *sex* (male, female), *grade* (9, 10, 11, 12, other), *ethnicity* (White, non-White), and *weekly spending money* (zero, $1–$20, $21–$100, $100+, don't know), were included as demographic covariates.

Analysis

Descriptive statistics were calculated for the entire sample. Chi-square statistics and Cramer's V were used to compare descriptive statistics by sex for categorical variables. Cramer's V is a measure of effect size from 0 to 1 where values greater than 0.1 indicate an effect.[53]

To create substance use classes and examine their associations with anxiety and depression, latent class analysis (LCA)[54] was implemented using Mplus version 8.2 (Muthen & Muthen, Los Angeles, CA, USA). LCA is a measurement model that uses categorical variables to identify homogenous latent classes within the data that are mutually exclusive and exhaustive.[54] First, a series of LCA models were fit to determine the number of classes to best fit the data. Categorical indicators of alcohol use, cannabis use, cigarette use and e-cigarette use were used as latent class indicators.

Using multiple group LCA, we evaluated whether there were statistically significant differences in class membership by sex ($p < 0.05$). Sex was first used as a grouping variable to explore differences among male and female students. Chi-square tests for measurement invariance compared models in which classes were fixed and then allowed to vary by sex. Tests indicated significant differences in classes between males and females. Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) values indicated better model fit when classes were allowed to vary by sex. Therefore, separate classes were created for male and female students and the following steps were carried out separately for males and females.

To establish the best-fitting LCA solution, we started with a one-class solution and added classes until good fit was no longer obtained. We used log-likelihood, AIC, BIC and the Lo-Mendell-Rubin adjusted likelihood ratio test (LMRT) as indicators of model fit. Lower log-likelihood, AIC and BIC values indicate better model fit.[55] The LMRT tests whether a model with k classes fits better than a model with $k-1$ classes; a significant result indicates that it does.[56] These model selection criteria, combined with model interpretability, were used to place participants into the appropriate latent classes. While entropy was not used for model selection, it is reported as an indicator of classification from zero to one, with larger values indicating better latent class separation.[54,57]

After identifying substance use classes using LCA, we conducted multinomial logistic regression to examine how anxiety and depression were associated with likelihood of membership in each class using the R3STEP command in Mplus.[58] Covariates included in the model were sex, grade, ethnicity, weekly spending money, family support, friend support and truancy. The TYPE = COMPLEX and CLUSTER commands in MPlus were used to account for the nesting of students within schools.

Results

Descriptive statistics

About half of the sample was female, and over two-thirds identified as White (Table 1). In 2017/18, 40% of students reported no substance use, 22% reported the use of one substance (i.e. past-year use of alcohol or cannabis or ever use of cigarettes or e-cigarettes) and 38% reported the use of two or more substances. Just over half of students reported having used alcohol in the past year (52%), whereas most had not used cannabis in the past year (77%). Overall, 23% of students reported trying cigarettes and 37% reported trying e-cigarettes. Most students reported having family (59%) and friend (76%) support and no truancy in the past four weeks (67%). Overall, 40% of students indicated having anxiety and/or depression. Chi-square tests indicated significant differences by sex for all variables except grade, while Cramer's V only indicated an effect for e-cigarette use (ever use: female 32%; male 41%) and anxiety and depression (anxiety and/or depression: female 50%; male 29%).

Substance use classes

A three-class model was selected as the best fitting model, as it had lower values for the model selection criteria and a more appropriate interpretation than its smaller and larger counterparts (Table 2).

The three classes identified in this study were named *poly-use class*, *dual use class* and *non-use class* (Table 3; Figure 1). The high-use class, *poly-use*, made up 11% of the female sample and 15% of the male sample. This class had the highest probability of all forms of substance use. Female students in this class were most likely to use alcohol one to three times per month and cannabis once per week or more often, to have tried cigarettes and to have used e-cigarettes on six or more days in the past month. Male students in this class were most likely to use alcohol and cannabis once per week or more, to have used cigarettes one to five days in the past month and to have used e-cigarettes six or more days in the past month. The *dual use class* made up 26% of the female sample and 26% of the male sample. This class had a relatively high probability of alcohol and e-cigarette use, and a lower probability of cannabis and cigarette use. Finally, the *non-use class* represented the students reporting no or low use. This class made up 62% of the female sample and 59% of the male sample. Students in this class were most likely to report no past-year alcohol or cannabis use and never having tried cigarettes or e-cigarettes.

Mental illness and substance use classes

Anxiety and depression were first explored descriptively by substance use class (Figure 2). Among females, those with only anxiety had 1.48 (95% confidence interval [CI]: 1.20–1.83) higher odds of being in the poly-use class and had 1.33 (1.16–1.51) higher odds of being in the dual use class than in the non-use class (Table 4). Those with only depression had 2.65 (2.31–3.04) higher odds of being in the poly-use class and 1.48 (1.34–1.64) higher odds of being in the dual use class compared to the non-use class. Finally, those with both anxiety and depression had 4.09 (3.59–4.65) higher odds of being in the poly-use class and 1.81 (1.65–1.99) higher odds of being in the dual use class than in the non-use class.

Among males, those with only anxiety had 1.41 (1.14–1.73) higher odds of being in the poly-use class compared to the non-use class. Differences between the dual use and non-use class were not statistically significant. Those with only depression had 1.69 (1.52–1.87) higher odds of being in the poly-use class and 1.21 (1.10–1.34) higher odds of being in the dual use class compared to the non-use class. Finally, those with both anxiety and depression had 2.48 (2.19–2.80) higher odds of being in the poly-use class and 1.18 (1.05-1.32) higher odds of being in the dual use class.

Discussion

This study examined a sample of Canadian adolescents from Alberta, British Columbia, Ontario and Quebec schools. We identified that three in five adolescents used one or more substances and two in five students experienced clinically relevant psychiatric symptomatology. Co-occurrence of anxiety and depression was high, especially among female students; few students identified as having anxiety alone. The high prevalence of substance use and symptoms of anxiety or depression in this population during an important developmental period is a cause for concern.

Despite statistical tests indicating that classes differed by sex, similar classes were identified for female and male students. Results from the latent class analysis indicated three different patterns of substance use: poly-substance use, dual substance use and non-use. While similar classes were identified for female and male students, a higher proportion of male students were in the poly-substance use class and male students were more likely to use substances at a higher

TABLE 1
Descriptive characteristics of the Year 6 (2017/18) COMPASS sample, by sex (British Columbia, Alberta, Ontario and Quebec, Canada)

Variable	Total sample (n = 51 767)		Female (n = 26 308)		Male (n = 25 459)		Chi-square / *t* test *p*-value	Cramer's V
	n	%	n	%	n	%		
Grade								
9	12 197	23.6	6 212	23.6	5 985	23.5	0.91	0.00
10	12 767	24.7	6 493	24.7	6 274	24.6		
11	12 406	24.0	6 328	24.0	6 078	23.9		
12	8 168	15.8	4 111	15.6	4 057	15.9		
Other[a]	6 229	12.0	3 164	12.0	3 065	12.0		
Ethnicity								
White	34 890	67.4	17 859	67.9	17 031	66.9	0.02	0.01
Non-White	16 877	32.6	8 449	32.1	8 428	33.1		
Weekly spending money								
Zero	8 318	16.1	3 777	14.4	4 541	17.8	< 0.01	0.08
$1–$20	13 029	25.2	6 750	25.7	6 279	24.7		
$21–$100	12 433	24.0	6 755	25.7	5 678	22.3		
$100+	9 819	19.0	4 545	17.3	5 274	20.7		
Don't know	8 168	15.8	4 481	17.0	3 687	14.5		
Past-year alcohol use								
None	24 537	47.6	12 184	46.5	12 353	48.7	< 0.01	0.08
< 1 x /month	10 532	20.4	5 939	22.7	4 593	18.1		
1–3 x /month	11 930	23.1	6 256	23.9	5 674	22.4		
≥ 1 x /week	4 568	8.9	1 838	7.0	2 730	10.8		
Missing	200							
Past-year cannabis use								
None	39 808	77.1	20 459	77.9	19 349	76.2	< 0.01	0.06
< 1 x /month	4 959	9.6	2 724	10.4	2 235	8.8		
1–3 x /month	3 088	6.0	1 556	5.9	1 532	6.0		
≥ 1 x /week	3 790	7.3	1 515	5.8	2 275	9.0		
Missing	122							
Cigarette use								
None	39 820	77.0	20 456	77.8	19 364	76.1	< 0.01	0.04
Ever use	7 049	13.6	3 609	13.7	3 440	13.5		
1–5 days (in past month)	2 790	5.4	1 358	5.2	1 432	5.6		
6+ days (in past month)	2 067	4.0	869	3.3	1 198	4.7		
Missing	41							
E-cigarette use								
None	32 616	63.4	17 733	67.7	14 883	58.9	< 0.01	0.13
Ever use	7 522	14.6	3 741	14.3	3 781	15.0		
1–5 days (in past month)	6 844	13.3	3 278	12.5	3 566	14.1		
6+ days (in past month)	4 494	8.7	1 447	5.5	3 047	12.1		
Missing	291							
Family support								
No	21 245	41.0	11 632	44.2	9 613	37.8	< 0.01	0.07
Yes	30 522	59.0	14 676	55.8	15 846	62.2		

Continued on the following page

TABLE 1 (continued)
Descriptive characteristics of the Year 6 (2017/18) COMPASS sample (n = 51 767), by sex (British Columbia, Alberta, Ontario and Quebec, Canada)

Variable	Total sample (n = 51 767)		Female (n = 26 308)		Male (n = 25 459)		Chi-square / *t* test *p*-value	Cramer's V
	n	%	n	%	n	%		
Friend support								
No	12 684	24.5	6 012	22.9	6 672	26.2	< 0.01	−0.04
Yes	39 083	75.5	20 296	77.2	18 787	73.8		
Truancy								
No	34 648	66.9	17 212	65.4	17 436	68.5	< 0.01	−0.03
Yes	17 119	33.1	9 096	34.6	8 023	31.5		
Anxiety and depression symptoms								
None	31 335	60.5	13 224	50.3	18 111	71.1	< 0.01	0.24
Anxiety only	2 209	4.3	1 450	5.5	759	3.0		
Depression only	7 764	15.0	4 206	16.0	3 558	14.0		
Both	10 459	20.2	7 428	28.2	3 031	11.9		

Notes: Anxiety symptoms were assessed using the GAD-7 scale; depression symptoms were assessed using the CES-D-10. A score of ≥ 10 was used as the cut-off to indicate anxiety and depression. Family/friend support refers to students agreeing with the statement "I can talk about my problems with my family/friends."

[a] Primarily Grades 7 and 8 equivalents.

frequency. This result supports research that has found males more likely to belong to higher-use categories,[4,5,9,13-18] although others have found no difference[19-22] or increased risk for females in certain poly-use classes (e.g. nonmedical use of prescription medication, not measured in this study).[23,24] It should be noted that measures of substance use did not differentiate between simultaneous use (i.e. "true" co-use) and concurrent use (i.e. sequential use); therefore, students in the poly-substance use class did not necessarily use substances simultaneously.

These results are consistent with a recent systematic review that identified typical patterns of substance use among adolescents: a low-use or no-use class comprising the most adolescents, a predominantly alcohol-use class, and finally high multi-use groups.[6] Our study findings differed from that review in two main ways. First, we identified only one multi-use group, while other studies have identified a moderate and a high multi-use group;[14,24,59-62] although many of these surveys included additional illicit substances (i.e. ecstasy, amphetamines, cocaine[14,24,59]), which were not examined in this study.

Second, rather than a predominantly alcohol-use class, we identified a dual use class that also included trying e-cigarettes. This is similar to a USA study that identified an alcohol and e-cigarette use class.[9] These findings highlight that adolescent prevention and treatment strategies should consider substance use patterns, including dual and poly-substance use.

The current study highlights the importance of including e-cigarette use or vaping when examining patterns of adolescent substance use. It is often included with cigarettes as a tobacco product; however, trends in use are diverging.[63] For example, in 2017/18, 13% of adolescents reported exclusive e-cigarette use while only 3% reported cigarette use and 5% reported dual use, although e-cigarette use has been found to predict future dual use.[64] While previous studies have identified an "alcohol only" class,[25,61,65] that was not the

TABLE 2
Model fit indices for 1 through 7 latent class models of substance use in Year 6 (2017/18) of the COMPASS study, by sex

Number of classes	Log-likelihood	FP	AIC	BIC	LMRT *p*-value	Entropy
Female						
1	−96 491.1	12	193 006.2	193 066.2	—	1.00
2	−84 113.0	25	168 276.0	168 400.9	0.00	0.82
3	**−82 633.7**	**38**	**165 343.4**	**165 533.4**	**0.00**	**0.76**
4	−82 435.3	51	164 972.6	165 227.6	0.02	0.78
5	−82 247.2	64	164 622.4	164 942.3	0.77	0.74
6	−82 191.3	77	164 536.7	164 921.6	0.78	0.69
7	−82 157.8	90	164 495.5	164 945.5	0.79	0.72
Male						
1	−100 222.3	12	200 468.7	200 528.3	—	1.00
2	−86 759.7	25	173 569.5	173 693.6	0.00	0.84
3	**−85 059.5**	**38**	**170 195.0**	**170 383.7**	**0.00**	**0.76**
4	−84 853.8	51	169 810.0	170 062.9	0.06	0.73
5	−84 744.9	64	169 617.7	169 935.6	0.26	0.74
6	−84 706.9	77	169 567.8	169 950.2	0.66	0.74
7	Did not converge					

Abbreviations: AIC, Akaike information criterion; BIC, Bayesian information criterion; FP, free parameters; LMRT, Lo-Mendell-Rubin Test.

Notes: Bold typeface signifies class model selected. "—" signifies no value.

TABLE 3
Conditional item-response probabilities and the prevalence of substance use behaviours in Year 6 (2017/18) of the COMPASS study, by sex

Variable	Female			Male		
	Class 1 Poly-use	Class 2 Dual use	Class 3 Non-use	Class 1 Poly-use	Class 2 Dual use	Class 3 Non-use
Latent class prevalence	11.4%	26.2%	62.4%	14.7%	26.0%	59.3%
Past-year alcohol use						
None	0.04	0.10	0.73	0.05	0.15	0.76
< 1 x /month	0.11	0.35	0.19	0.09	0.32	0.14
1–3 x /month	0.49	0.47	0.08	0.40	0.43	0.08
≥ 1 x /week	0.36	0.08	0.01	0.47	0.10	0.02
Past-year cannabis use						
None	0.11	0.63	1.00	0.13	0.63	0.99
< 1 x /month	0.21	0.27	0.00	0.17	0.22	0.01
1–3 x /month	0.28	0.09	0.00	0.22	0.10	0.00
≥ 1 x /week	0.41	0.02	0.00	0.49	0.05	0.00
Cigarette use						
None	0.12	0.64	0.98	0.12	0.66	0.98
Ever use	0.33	0.31	0.02	0.29	0.29	0.02
Past month, 1–5 days	0.30	0.05	0.00	0.30	0.04	0.00
Past month, 6+ days	0.25	0.01	0.00	0.30	0.01	0.00
E-cigarette use						
None	0.15	0.35	0.95	0.06	0.23	0.90
Ever use	0.17	0.34	0.04	0.09	0.34	0.07
Past month, 1–5 days	0.33	0.27	0.01	0.27	0.32	0.02
Past month, 6+ days	0.35	0.04	0.00	0.58	0.11	0.00

case in this study. Our dual use class comprised a quarter of the students, and the presence of this class indicates that students who were previously only experimenting with alcohol a few times per month may now also be experimenting with e-cigarettes. In the poly-substance use class, e-cigarette use was more frequent than in the dual use class. Due to the negative effects of nicotine on the developing brain[66] and the largely unknown long-term effects of e-cigarette use on lung health,[67] the prevalence of this dual use class is concerning and should be considered in future work examining adolescent substance use. It is important for surveillance work to be able to monitor the use of new substances that emerge in the marketplace and how new products and changes to regulations may impact substance use profiles among adolescents.

The descriptive statistics showed a gradient in anxiety or depression symptom prevalence across classes (Figure 2). Those in the poly-use class had the highest prevalence of anxiety and depression, followed by the dual use class and the non-use class. While other studies have also identified this gradient, it has not been previously examined by sex.[11,38] Notably, prevalence of anxiety and depression in the lowest-risk group (i.e. non-use) among females (23%) was similar to prevalence in the highest-risk group (i.e. poly-substance use) among males (20%). Based on these

FIGURE 1
Substance use item probabilities for three-class latent class model in Year 6 (2017/18) of the COMPASS study, by sex

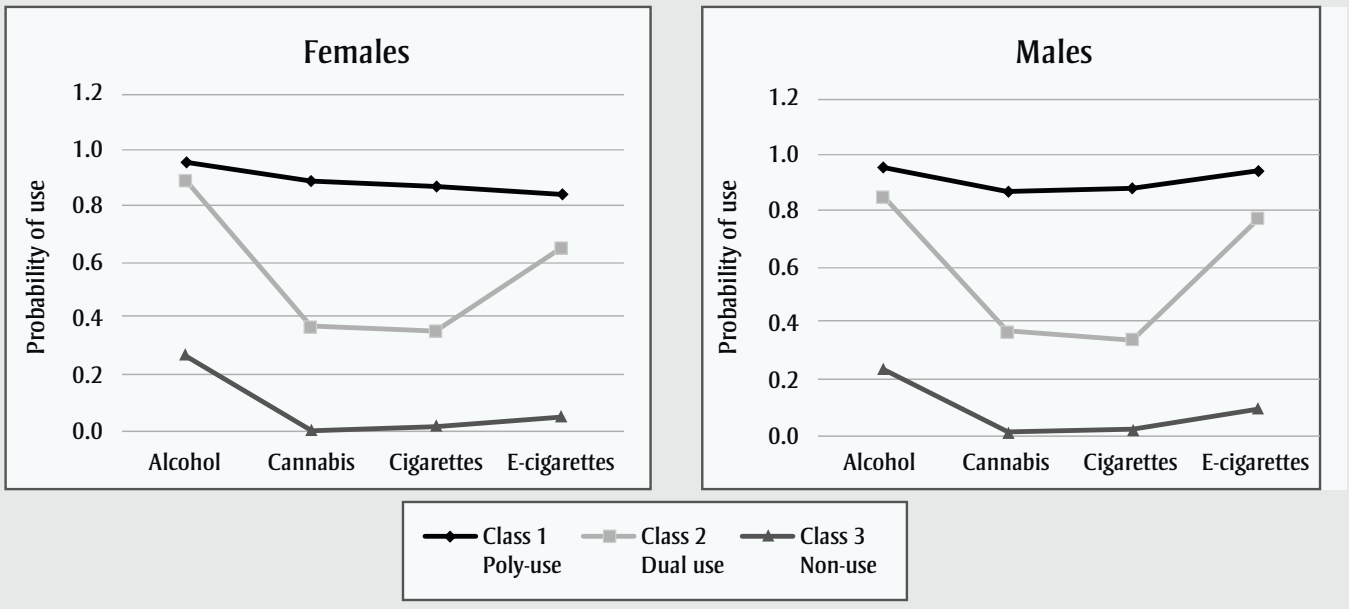
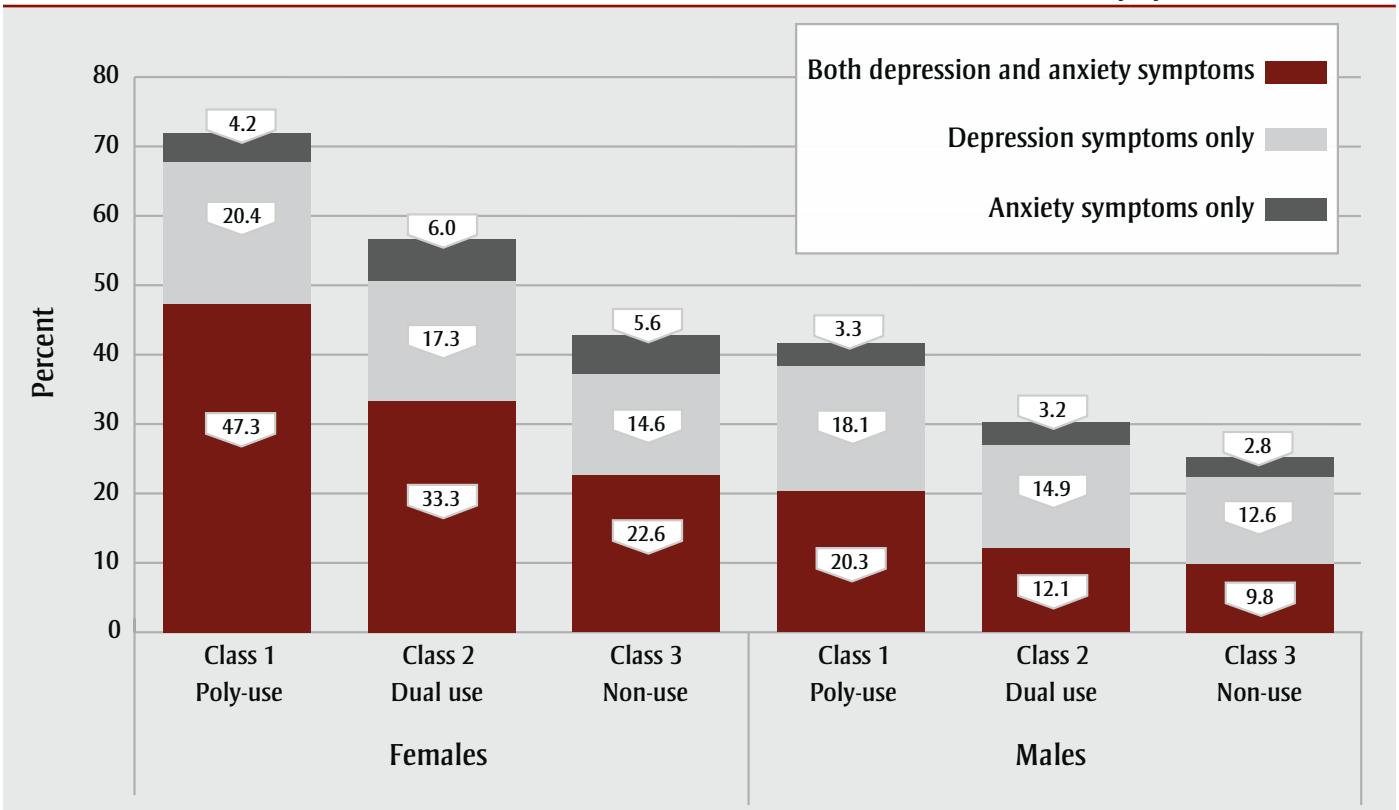


FIGURE 2
Estimated proportion of students reporting clinically meaningful symptoms of anxiety, depression or both in each of the three latent classes of substance use in Year 6 (2017/18) of the COMPASS study, by sex



findings, female students should be a priority population for mental health programming.

This study identified an association between substance use classes and anxiety and depression. These results are in line with many other studies that have examined adolescent substance use and anxiety and/or depression.[11,38,39] While the current research does not address direction of effect, some explanatory theories for this relationship have been proposed. First is the hypothesis that individuals use substances to cope with existing symptoms.[68] This is supported by evidence that has found that depression during adolescence predicts future increased substance use, although there are variations by sex and substances used.[28,69,70] Nevertheless, the evidence does not always support this direction of effect.[35] Other researchers hypothesize lowered mood is a direct result of substance use in adolescence.[71] Regardless of the direction of effect, these results emphasize the need to assess symptoms of anxiety and/or depression among students who are found to be using substances and vice versa.

TABLE 4
Substance use class membership by symptoms of anxiety and/or depression in Year 6 (2017/18) of the COMPASS study, by sex

Symptoms	Odds ratio (95% CI)	
	Class 1 vs. class 3[a]	Class 2 vs. class 3[a]
Female students		
None	1.00	1.00
Anxiety symptoms only	1.48 (1.20–1.83)	1.33 (1.16–1.51)
Depression symptoms only	2.65 (2.31–3.04)	1.48 (1.34–1.64)
Both	4.09 (3.59–4.65)	1.81 (1.65–1.99)
Male students		
None	1.00	1.00
Anxiety symptoms only	1.41 (1.14–1.73)	1.13 (0.94–1.37)
Depression symptoms only	1.69 (1.52–1.87)	1.21 (1.10–1.34)
Both	2.48 (2.19–2.80)	1.18 (1.05–1.32)

Abbreviation: CI, confidence interval.

Note: Models adjusted for grade, ethnicity, weekly spending money, family support, friend support and truancy.

[a] Class 1 is the poly-substance use class, class 2 is the dual use class and class 3 is the non-use class.

It should be noted that, in contrast to our results, Halladay et al.[6] identified subgroups of adolescents with distinct substance use and mental health concerns. While we were not able to identify these students in regression analyses, they were present in our descriptive examination of our sample. For example, 28% of females and 58% of males in the poly-substance use class did not report anxiety or depression.

Strengths and limitations

This study has several strengths. The COMPASS study has a large sample size

and uses measures based on national surveillance tools.[52] The questionnaire uses an active-information passive-consent protocol to encourage participation and honest reporting, which has been shown to be particularly important in substance use and mental health research.[42,72,73] In addition, this study had a good participation rate, with data available for 78% of all participants. Finally, we made use of validated scales for anxiety and depression to assess students' symptoms.

This study was not without limitations. First, we made use of cross-sectional data, preventing causal inferences. Second, the COMPASS study was designed to evaluate changes in school programs and policies and therefore uses a convenience sample that is not representative of Canadian high school students. Third, there are limitations to the questionnaire used. There could be reporting bias in the substance use questions due to the illicit nature of substances for underage youth, whereby participants may have underreported their use. Other illicit substances were not examined in this study, potentially further contributing to the underreporting of substance use. The questionnaire also lacked a definition of e-cigarette use and may have also captured some cannabis use in this measure. Additionally, measures of anxiety, depression and substance use were not indicative of diagnosed clinical disorders. These disorders are prevalent and have a large impact on health service use among young people.[74,75] We were also lacking measures of peer or family substance use, which is associated with early initiation and escalating use through adolescence.[26] However, this study made use of variables indicating family and friends support, which have been negatively and positively associated with poly-substance use, respectively.[4] Furthermore, there were no measures available of parental psychopathology, which is a significant risk factor for children.[76,77] Fourth, there was much missing data on the outcome variables in this study (19%); however, there were no significant differences in the outcome variable in chi-square tests comparing those included and those excluded based on missing data.

Conclusion

Half of female students and almost one-third of male students reported clinically relevant symptoms of anxiety and/or depression. Co-occurrence of anxiety and depression was common, and few students reported anxiety only. We identified three substance use classes: poly-use, dual use and non-use. Those with both anxiety and depression or depression only were more likely to belong to the poly-substance use and dual use classes than the non-use class. Anxiety was associated with belonging to the poly-substance use class among female and male students and belonging to the dual use class among female students.

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Conflicts of interest

Scott Leatherdale is an Associate Scientific Editor with the HPCDP Journal, but has recused himself from the review process for this paper. The authors declare there are no other conflicts of interest.

Authors' contributions and statement

GCW conceived this work, conducted the analyses and drafted the manuscript as part of her PhD dissertation at the University of Waterloo. STL supervised GCW in conceptualizing this project and drafting the manuscript. KAP and MAF provided ideas and thoughts for discussion and revised the manuscript for important intellectual content. STL is the principal investigator of the COMPASS study, wrote the funding proposal, developed the tools and led study implementation and coordination. All authors supported GCW in study design and analysis plan and read and approved the final manuscript.

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