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Implications of concurrent binge drinking and mental health problems among Canadian youth

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Implications of concurrent binge drinking and mental health problems among Canadian youth

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ABSTRACT

Objective: The objective of this study was to examine the psychosocial correlates of binge drinking among a large sample of Canadian youth, while testing the moderating effect of flourishing on the potential relationship between binge drinking and clinically-relevant symptoms of mental health problems.

Design: cross-sectional

Setting: 14 secondary schools across Ontario and British Columbia Canada

Participants: A sample of grade 9-12 students (n=6570) who participated in the Mental Health pilot of the COMPASS study

Primary and secondary outcome measures: self-reported questionnaires were completed by students measuring binge drinking and its frequency associated with depression and anxiety symptoms.

Results: In our sample of 6,570 students, 37.0% of students report binge drink in the last year, and 41.4% of students report clinically relevant symptoms of depression and 31.7% for anxiety. Anxiety (OR: 0.57 [0.15-2.22]) and depression (OR: 1.98 [0.76-5.13]) symptoms were not found to be associated with binge drinking and we did not detect any moderating role of flourishing. Rather, factors that were associated with increased odds of binge drinking included sports team participation (OR: 1.67 [1.37-2.03]) and use of other substances (tobacco (OR: 3.00 [2.12-4.25]) and cannabis (OR: 7.76 [6.36-9.46])). Similar associations were found for frequency of binge drinking.

Conclusions: Consistent with existing literature, binge drinking behaviours were common, as were sub-clinical symptoms of depression and anxiety. However, mental health problems and wellbeing may not be responsible for explaining patterns of binge drinking in youth. Instead, our findings suggest that alcohol use among youth may be a product of social acceptability and normalcy. Targeted intervention efforts towards student athletes and concurrent substance users are necessary for addressing binge drinking in youth populations.

Article Summary

- The COMPASS project is a unique data system that examines Canadian youth risk behaviours, and provides an ideal platform to evaluate naturally occurring behaviours and changes over time
- COMPASS uses a purposeful sampling method, and so results are not representative of all Ontario and British Columbia high schools.
- Since student data are self-reported, findings may be subject to reporting or recall bias, however, passive permission protocols have been implemented to preserve anonymity.
- Mental health items were measured using scales and were based on 1-2 week recall; as such, these measures are not diagnostic and cannot determine whether symptoms were chronic or short term.
- Lastly, this study was unable to examine broader social environments that may be associated with alcohol consumption patterns, and was unable to establish binge drinking trajectories in relation to mental health problems given the cross-sectional nature of the data.

Introduction

Although provincial legislation prohibits alcohol consumption for those under the age of 18 or 19, binge drinking remains highly prevalent among high school aged youth in Canada. Nearly 1 in 4 Canadian adolescents report past-year binge drinking (1), which has been operationally defined in previous studies as consuming five or more drinks on one occasion.(2–4) Acute and chronic health risks associated with adolescent alcohol use can be severe, including potential neurologic and psychosocial concerns. The developing brain is especially vulnerable to the effects of alcohol, particularly in high volumes and frequent doses.(5,6) Alcohol consumption during adolescence may contribute to future experiences of psychiatric and substance use disorders (5,7) and youth who partake in binge drinking are at highest risk for such adverse health outcomes.(8,9)

Binge drinking (10–12) and frequency of drunkenness (13) that often stem from binge drinking, during adolescence have been linked to negative psychological outcomes including conduct disorder, anxiety, depression, and suicidal behaviour. Depression in youth has been suggested to lead to binge drinking in attempt to reduce negative emotions.(14,15) For instance, Weitzman found that approximately 80% of college students who indicated depressive symptoms also reported recent consumption of alcohol.(16) Moreover, binge drinking has many negative physiological effects on the brain (17) and may lead to impaired mood and feelings of depression, particularly in children.(12)

Normative social influence and cultural norms may also play an important role in explaining drinking patterns (18,19), as such behaviour may result from interactions within surrounding social environments.(20) Ubiquitous advertising of alcohol in Canada may contribute to positive perceptions of drinking.(21,22) Such perceptions can create an environment where drinking behaviour is both accepted and encouraged socially, and may initiate or lead to an increase in alcohol consumption and binge drinking.(21,23,24) Despite binge consumption levels of alcohol being a hazardous health behaviour associated with many physical and psychosocial problems (17), it is often viewed as a social activity; an important aspect to consider when measuring overall mental wellbeing. One study found that drinking with friends is protective against alcohol-related problems (25), suggesting that social drinking may coincide with aspects of positive psychosocial wellbeing such as social participation, enhanced self-esteem, coping strategies, personal autonomy, and accountability.(26)

New research has demonstrated that positive psychosocial wellbeing, or *flourishing*, may have a protective effect against adolescent mental health problems and cannabis use.(27) This study found an important association between cannabis use and mental health problems within a youth population, where youth who had poorer mental wellbeing were more likely to use cannabis and at greater frequencies.(27) Given the paucity of available literature on the effects of flourishing, additional research on the influence of overall wellbeing within other substance use domains, such as adolescent binge drinking, is warranted. The objective of this study was to assess the relationship between binge drinking and mental health problems including depression and anxiety among a large sample of Canadian youth. Additionally, we aim to contribute to the literature by examining whether flourishing will moderate the association between mental health problems and binge drinking behaviour within Canadian high school students.

Methods

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4 The COMPASS Study is a longitudinal, prospective cohort study (2012-2021) that collects data
5 from students in grades 9 to 12 attending participating secondary schools across Canada.(28) A new
6 mental health module (MH-M) measuring student mental health was piloted in year 5 COMPASS data
7 collections (Y₅[2016-2017]), as this was identified by stakeholders as a priority area for student
8 health.(29) This paper uses the data collected from students attending the 14 COMPASS schools that
9 were selected to participate in the MH-M pilot via the COMPASS student questionnaire.(29) The original
10 COMPASS study protocol was maintained with the exception of the eight new subsections about youth
11 mental health that were added to supplement the original student questionnaire.(28,30,31) A complete
12 description of COMPASS methods is available in print (28) or online (www.compass.uwaterloo.ca). This
13 study received ethics approval from the University of Waterloo Human Research Ethics Committee and
14 all participating school boards.
15

16
17 Data were collected from 8,344 students attending selected secondary schools in British
18 Columbia (N=5) and Ontario (N=9), Canada. Specific schools were recruited to participate in the pilot
19 stage of the mental health module during year 5 of the COMPASS data collection based on expressed
20 interests in the mental health data. Students were recruited using a parental active-information passive-
21 consent permission protocol (28), a strategy shown to be important for collecting robust data on self-
22 reported risk behaviours such as substance use among youth.(32–34) A complete-case analysis was used
23 for this manuscript (N=8,344), resulting in a final analytic sample of 6,570 students.
24

25 Measures

26 *Binge Drinking*

27
28 Consistent with previous research (4), binge drinking was assessed by asking students “In the
29 last 12 months, how often did you have 5 drinks of alcohol or more on one occasion?” Responses were
30 recoded into a binary measure of binge drinking, where students who indicated never having done this,
31 were classified as “non-current binge drinkers” and all other responses were coded as “current binge
32 drinkers.” For ordinal responses, binge drinking frequency was collapsed into the following: “non-
33 current binge drinkers,” consistent with the binary variable explained above; “rare/sporadic,” if
34 respondents indicated binge drinking less than once a month; “monthly,” if reported use was once to 3
35 times per month, and; “weekly,” if use ranged from once a week to daily.
36

37 *Mental health variables*

38
39 Youth depressive symptoms were assessed using *the Center for Epidemiologic Studies*
40 *Depression Scale (Revised)-10 (CESD-R10; (35))*. This 10-item scale was designed to assess self-reported
41 symptoms associated with depression such as feelings of sadness, loss of interest, difficulties sleeping,
42 making decisions, and concentrating over a 1-week period.(35–37) Internal consistency of the CESD-R-10
43 scale was high ($\alpha=0.98$). Anxiety symptoms were measured using *the Generalized Anxiety Disorder 7-*
44 *item Scale (GAD-7; (38))*. The GAD-7 reports on self-perceived feelings of worry, fear, and irritability over
45 a 2-week period of time and had high internal consistency ($\alpha=0.99$). Both scales have been validated for
46 use in adolescent populations.(36–38) The CESD-R-10 and GAD-7 scales were fit as dichotomous
47 variables for each model; consistent with other research, this study applied a binary coding system to
48 categorize students with and without clinically relevant symptoms (control=0, depression and/or
49 anxiety=1) using scores ≥ 10 for both depression (37) and anxiety (38) to indicate the presence of mental
50 health problems.
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53
54 Levels of psychosocial prosperity and wellbeing among students was measured using *the*
55 *Flourishing Scale (FS; (39))*. This scale provides a score that represents overall psychological wellbeing on
56 a flourishing-languishing continuum by assessing how students perceive their: relationships; life purpose
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59

and satisfaction; engagement with and interest in daily activities; self-esteem; competence, and; optimism. To remain suitable for large, school-based studies (31), the original 7-point Likert scale was reduced to a 5-point response option with total scores ranging from 8 to 40. All item statements are positively framed within the original FS.(39) However, to remain consistent with the other COMPASS MH-M measures, the FS was reverse coded; high scores represent languishing – an indication of mental health problems. Internal consistency of the FS was high ($\alpha= 0.98$).

Covariates

Existing knowledge indicates that adolescent males may be most likely to participate in binge drinking behaviour.(9) Harmful health behaviours have been shown to cluster together in adolescence, indicating a propensity in binge drinkers to be concurrent tobacco and cannabis users.(40) Previous studies have cited risk-taking behaviour (41), unhealthy weight-control methods (42), and participation in team sports (43) as common binge drinking risk factors among high school students. As such, the following covariates were accounted for: grade (9, 10, 11, 12); sex (female, male); ethnicity (White, Black, Asian, Indigenous [First Nations, Métis, Inuit], Latin American or Hispanic, Mixed/Other); weekly spending money (\$0, \$1-\$20, \$21-\$100, more than \$100, I don't know) as a proxy for socioeconomic status as this is a more accessible value for youth to report on than household income; truancy (no skipped classes, 1 or more missed classes per week); cannabis use (never use, ever user [ever using marijuana]); smoking status (non-smoker [reported never smoking or non-current use of cigarettes], current smoker [reported smoking one or more cigarettes in the past month]) and team sport involvement (not involved, involved [school or community level]).

Analysis

Among our analytic sample, descriptive analyses were conducted using χ^2 and *t* tests. Binge drinking status (non-current vs current binge drinker) was modelled using a binary logistic regression (model 1) and binge drinking frequency was modelled using an ordinal logistic regression (model 2) which adjusted for relevant covariates. Given the large sample size, a confidence interval of 99% was used. The frequency of binge drinking was modeled to examine if mental health problems were associated with increasing levels of binge drinking frequencies. To examine flourishing as a moderating variable within the association between mental health problems and binge drinking behaviours, 2- and 3-way interactions between flourishing, depression and anxiety were tested. All analyses were conducted in SAS 9.4.(44)

Results

Sample characteristics

Demographic characteristics for the total sample (n=6,570) are presented in Table 1. The majority of students reported their ethnicity as white (71.4%) and 51.6% were female. Overall, 37.0% of the sample reported binge drinking at least once within the past year and 20% indicated binge drinking at least once a month. Mental health problems were common within the study sample: 41.4% of students reported clinically relevant symptoms (scores ≥ 10) for depression and 31.7% reported symptoms of anxiety (scores ≥ 10). The mean flourishing score was 16.66 (SD:5.87) and after stratifying descriptive results by sex, females (17.23 [SD:6.00]) reported poorer mean flourishing scores than males (15.99 [SD:5.65]). Compared to their male counterparts, females more commonly reported clinically relevant symptoms of depression (51.9% vs 30.1%) and anxiety (43.5% vs 19.1%). Females were also more likely to be sporadic (18.7% vs 15.3%) and monthly (15.2% vs 14.6%) binge drinkers and less likely to binge drink weekly (3.9% vs 6.3%) compared to males.

Correlates of drinking behaviours

Table 2 demonstrates results of the regression models used for predicting binge drinking behaviours. Current binge drinkers were more likely to be in grade 10 [OR 1.56, $p < 0.001$], grade 11 [OR 1.69, $p < 0.001$], and grade 12 [OR 2.31, $p < 0.001$]. The same demographic trends were observed in Model 2 for binge drinking frequency, whereby students in older grades were more likely to report higher binge drinking frequencies and the odds of this increased for every grade level. As seen in model 2, cannabis use [OR 7.76, $p < 0.001$], tobacco smoking [OR 3.00, $p < 0.001$], truancy [OR 2.29, $p < 0.001$] and being involved on a sports team [OR 1.67, $p < 0.001$] were significantly associated with an increased odds of binge drinking (Model 1). Similarly cannabis use [OR 7.12, $p < 0.001$], tobacco smoking [OR 3.94, $p < 0.001$], truancy [OR 2.04, $p < 0.001$] and being involved on a sports team [OR 1.64, $p < 0.001$] were associated with increases in binge drinking frequency. Compared to those who reported not having any spending money, youth with \$1-\$20 of weekly spending money were 1.37 times more likely to binge drink and the odds of binge drinking doubled (2.68) for youth with greater than \$100 of weekly spending money (Model 1).

Moderating effects of flourishing

Sub-clinical symptoms of depression and anxiety and self-reported flourishing were not found to be significantly associated with binge drinking or binge drinking frequency within our sample. Moreover, the addition of interaction terms did not lead to any changes in estimations or significance; therefore, flourishing did not moderate the association between mental health problems and binge drinking behaviours as hypothesized.

Discussion

Our results correspond with previous surveillance research and national averages showing alcohol is the most prevalent substance used among Canadian adolescents.⁽¹⁾ Our findings identified that almost one third of youth in Ontario and British Columbia, who participated in the COMPASS MH-M pilot study, reported binge drinking within the past 12 months and almost 1 in 6 students reported this behaviour monthly. Depression and anxiety were also found to be highly prevalent mental health problems among our large sample of youth; nearly one-half of students indicated symptoms of clinically relevant depression and one third reported clinically relevant symptoms of anxiety. Although highly prevalent, depression and anxiety were not associated with binge drinking, and flourishing was not found to be a moderating factor. Previous COMPASS research has identified an association between poor mental wellbeing and cannabis use (21), yet our findings indicate it is unlikely youth use alcohol for the same reasons as cannabis suggesting substance-specific interventions to be developed.

Our results supplement other substance use literature and identify that co-occurring substance use is common among students who binge drink.^(45–48) Current binge drinkers were approximately three times more likely to smoke tobacco and almost eight times more likely to use cannabis. In addition to substance use, sports team participation appeared to be a strong predictor of binge drinking. Adding this variable improved the predictive accuracy of our logistic models, as demonstrated by the concordance statistic. Although sports team participation contributes to positive health behaviours among youth (e.g. physical activity), it may also be associated with engagement in problematic behaviours; patterns of excessive alcohol consumption have been previously observed among school athletes (49).

Available literature linking youth mental health problems and binge drinking behaviours is inconsistent. While some studies have demonstrated that youth with mental health problems are more

likely to binge drink (14) or that youth binge drinking may lead to mental disorders (15), others have found no significant association.(50) Our findings are consistent with other COMPASS research using MH-M data, where neither depression nor anxiety were found to be significantly associated with other substance use behaviours such as cannabis after controlling for flourishing.(27) However, our findings do not imply that flourishing serves as a protective measure against binge drinking as seen with cannabis (27), suggesting that alcohol and cannabis may serve different social and psychological functions. While recent cannabis research suggest that mental health and wellbeing are associated with youth cannabis use, research examining reasons why adolescents participate in binge drinking suggests that social norms may play an important role in explaining such behaviour (18,19), and binge drinking is likely a function of direct and surrounding social environments.(20)

Substance use behaviours may be dependent on both environmental and individual factors. Previous studies have identified important links between social influences and binge drinking, ultimately providing support for the *Theory of Planned Behaviour*.(51–53) The Theory of Planned Behaviour is a psychosocial model that has been effectively applied to the prediction of many of health behaviours by outlining an individual's attitude, subjective norms, and perceived behavioural control.(54) Our findings provide support for the association between binge drinking patterns and the behavioural influences outlined by Theory of Planned Behaviour, as demonstrated elsewhere.(53,55) Schlegel et al. (55) found attitudes towards binge drinking and perceived social norms all contributed to the intention and frequency of binge drinking. More specifically, binge drinking in youth has been shown to be associated with peer group influences (56) and alcohol advertising (23), both of which demonstrate important intervention approaches. Distal factors of this theory such as socioeconomic status, were also found to be associated with binge drinking among our sample of youth. We identified a strong dose-response relationship between binge drinking and weekly spending money, indicating that socioeconomic status may be correlated with alcohol consumption among youth, whereby greater amounts of weekly spending money was associated with an increased likelihood of binge drinking and binge drinking frequency.

Existing literature indicates the perception of peer alcohol use may be the strongest predictor of adolescent drinking behaviour.(18) Underlying motives for alcohol consumption may represent important insight for intervention strategies given that alcohol consumption is situational and may differ across individuals.(57) For example, alcohol may be misused to help cope with negative emotions and may lead to psychological dependence and disorders.(57) On the contrary, alcohol may be consumed by others as a customary social behaviour as is common in many cultures.(58) For youth in particular, alcohol use and binge drinking is commonly social in nature.(18–20) Research has identified positive social gains and increases in popularity from youth engagement in risk-taking behaviours (20). This may provide reason for our lack of association found between mental health problems and binge drinking, and suggests that alcohol consumption may result due to social interaction and establishing relationships with peers. In addition to social and peer influences on attitudes and binge drinking behaviour, exposure to alcohol advertisements have been associated with alcohol consumption in young people.(23,24) It is possible that excessive exposure to alcohol advertisement may provoke positive attitudes about alcohol consumption and foster the social acceptability of this behaviour. These trends may translate into more general team sport involvement, as youth participation in team sports may also be an important risk factor for alcohol consumption and binge drinking.(49)

The Canadian Centre on Substance Abuse recognizes that while sports participation is linked to decreases in illicit drug use (e.g. cannabis) among youth, the use of alcohol increases.(59) Youth between the ages of 15 to 19 years have the highest participation rate in sports.(60) This presents an

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3 optimal opportunity to influence youth by leveraging their team sport environments and implementing
4 targeted prevention strategies.(59) Substance use is commonly initiated during adolescence, where
5 enrolment in sports is high, and as such, this is a critical period for substance use prevention efforts.(1)
6 Public health authorities may consider limiting or restricting alcohol promotion during events that may
7 be attended by youth. Additionally, there is a paucity of evidence considering the risk of binge drinking
8 within a team dynamic and as such, future research is warranted.
9

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11 Given the differences in significant predictors for alcohol and cannabis among the same sample
12 of COMPASS participants, it is necessary to consider tailored approaches for each individual substance,
13 rather than developing intervention programs that address the use of many substances simultaneously.
14 Based heavily on the Theory of Planned Behaviour, psychosocial research suggests that persuading
15 attitudes and norms to influence behaviour may be more effective at producing long-term changes.(61)
16 Successful strategies may involve peer-to-peer mentoring or social norming campaigns given the
17 influence peer groups may have on attitudes towards alcohol consumption and, in turn, binge drinking
18 behaviour.(18–20) As well, targeted intervention efforts may be effective if implemented within the
19 environment of a sports team dynamic to influence health behaviours. Research should aim to examine
20 substance use behaviours both separately and concurrently, and future exploration may consider the
21 possible association between mental health and wellbeing, and co-occurring alcohol and cannabis use;
22 such correlations and temporal relationships can be tested using future waves of COMPASS.
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24

25 *Conclusion*

26 A large proportion of the study sample of grade 9-12 students reports binge drinking. While
27 symptoms of depression and anxiety are also highly prevalent in this population, our research shows
28 that they are likely not responsible for explaining patterns of excessive alcohol consumption in our
29 youth sample. Contrary to our hypothesis, flourishing was not shown to moderate the relationship
30 between mental health and binge drinking in high school students. This new analysis of the COMPASS
31 mental health data and alcohol use among youth suggests that binge drinking among youth may be a
32 product of social acceptability and normalcy. Future interventions may consider peer-to-peer mentoring
33 and research should aim to consider the role of social environments and alcohol consumption, and
34 where data is available, targeting binge drinking within a team dynamic and among different types of
35 sports.
36
37

38 *Declarations*

39 **Ethics approval and consent to participate**

40 The COMPASS Study received ethics approval from the University of Waterloo Office of Research Ethics
41 as well as participating school boards (ORE #: 30118).

42 **Consent for publication**

43 Using an active-information, passive-consent protocol, all participants gave consent for the use of their
44 anonymous data.

45 **Data statement:**

46 A data request form to access to the COMPASS data can be found at: <https://uwaterloo.ca/compass-system/information-researchers/data-usage-application>

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Authors' contributions

AEB conceived the manuscript idea, performed the statistical analyses, drafted the manuscript and revised the manuscript for content. IR, MAF, KP, MG and YJ revised the manuscript for critical content. STL conceived the host study, led the acquisition of all data, drafted components of introduction and discussion, and revised the manuscript for critical content. All authors that have contributed significantly to the work presented within this manuscript has been listed above.

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Table 1. Sample descriptives by sex for grade 9-12 students in year 5 of the mental health pilot of COMPASS (2016-2017)

		Total N=6570	Female N=3389	Male N=3181	
		% (n) †	% (n) †	% (n) †	Chi-Square (p-value)
Grade	9 10 11 12	27.9 (1833) 29.3 (1923) 24.3 (1597) 18.5 (1217)	26.9 (913) 30.1 (1021) 24.0 (812) 19.0 (643)	28.9 (920) 28.4 (902) 24.7 (785) 18.0 (574)	5.18 (0.16)
Ethnicity	White Indigenous Asian Black Latin American Other/Mixed	71.4 (4476) 2.2 (135) 10.3 (645) 2.5 (156) 2.6 (164) 11.0 (694)	71.3 (2314) 2.0 (66) 10.6 (343) 1.9 (60) 2.0 (65) 12.2 (396)	71.5 (2162) 2.3 (69) 9.9 (302) 3.2 (96) 3.3 (99) 9.8 (298)	29.49 (<0.0001)
Province	Ontario British Columbia	57.1 (3749) 42.9 (2821)	56.7 (1920) 43.3 (1469)	57.5 (1829) 42.5 (1352)	0.48 (0.49)
Weekly spending money	\$0 \$1-\$20 \$21-\$100 >\$100 I don't know	15.3 (1004) 26.8 (175) 25.2 (1650) 20.1 (1318) 12.6 (820)	13.4 (451) 27.4 (924) 27.0 (913) 18.2 (614) 14.0 (476)	17.5 (553) 26.2 (829) 23.3 (737) 22.2 (704) 10.8 (344)	54.93 (<0.0001)
Varsity/community sport involvement	No Yes	67.1 (4377) 32.9 (2145)	71.4 (2398) 28.6 (962)	62.6 (1979) 37.4 (1183)	56.92, (<0.0001)
Truancy	No skipped classes 1 or more	59.8 (3898) 40.2 (2619)	58.2 (1954) 41.8 (1406)	61.6 (1944) 38.4 (1213)	7.93 (0.005)
Depression	No depression Depression (≥10)	58.6 (3852) 41.4 (2718)	48.1 (1629) 51.9 (1760)	69.9 (2223) 30.1 (958)	321.98 (<0.0001)
Anxiety	No Anxiety Anxiety (≥10)	68.3 (4488) 31.7 (2082)	56.5 (1915) 43.5 (1474)	80.9 (2573) 19.1 (608)	450.55 (<0.0001)
Flourishing (8-40)	Mean Score (SD)	16.63 (5.87)	17.23 (6.00)	15.99 (5.65)	tValue=8.54 (<0.0001)
Smoking status	Non-smoker Smoker	89.5 (5864) 10.5 (688)	89.8 (3036) 10.2 (345)	89.2 (2828) 10.8 (343)	0.65 (0.42)
Cannabis Use	Never used Ever used	67.6 (4421) 32.4 (2117)	67.7 (2287) 32.3 (1091)	67.5 (2134) 32.5 (1026)	0.02 (0.88)
Binge drinking status	Non-current binge drinker Binge drinker	63.0 (4137) 37.0 (2433)	62.2 (2109) 37.8 (1280)	63.7 (2028) 36.3 (1153)	1.63 (0.20)
Binge drinking frequency	Non-current binge drinker Rare/sporadic Monthly Weekly	63.0 (4137) 17.0 (1120) 14.9 (980) 5.1 (333)	62.2 (2109) 18.7 (631) 15.2 (516) 3.9 (133)	63.8 (2028) 15.3 (489) 14.6 (464) 6.3 (200)	29.27 (<0.0001)
† Note: The numbers may not add up to the total due to missing values and rounding. Complete case analysis was conducted; 12% of depression data and 19% of binge drinking data was missing.					

Table 2. Binge drinking for grade 9-12 students in year 5 of the COMPASS MH-M (2016-2017)

		Model 1 ^a	Model 2 ^b
		OR (99%CI) [†]	OR (99%CI) [†]
Sex	Female	1.00	1.00
	Male	0.94 (0.78-1.14)	1.09 (0.93-1.28)
Grade	9	1.00	1.00
	10	1.56 (1.21-2.00)**	1.51 (1.20-1.89)**
	11	1.69 (1.29-2.20)**	1.62 (1.28-2.06)**
	12	2.31 (1.74-3.07)**	2.13 (1.66-2.73)**
Ethnicity	White	1.00	1.00
	Indigenous	0.84 (0.45-1.57)	0.90 (0.55-1.47)
	Asian	0.47 (0.33-0.68)*	0.53 (0.38-0.73)*
	Black	0.63 (0.35-1.13)	1.07 (0.66-1.72)
	Latin American	1.05 (0.60-1.14)	0.96 (0.59-1.56)
	Other/Mixed	0.86 (0.64-1.14)	0.92 (0.72-1.17)
Province	Ontario	1.00	1.00
	British Columbia	0.81 (0.67-0.98)*	0.86 (0.73-1.01)
Weekly spending money	\$0	1.00	1.00
	\$1-\$20	1.37 (1.00-1.87)*	1.25 (0.94-1.67)
	\$21-\$100	2.45 (1.80-3.35)**	2.12 (1.60-2.80)**
	>\$100	2.68 (1.93-3.71)**	2.34 (1.88-2.90)**
	I don't know	1.56 (1.08-2.25)*	1.50 (1.17-1.93)*
Varsity/community sport involvement	No	1.00	1.00
	Yes	1.67 (1.37-2.03)**	1.64 (1.39-1.93)**
Truancy	No skipped classes	1.00	1.00
	1 or more	2.29 (1.90-2.76)**	2.04 (1.73-2.41)**
Smoking status	Non-smoker	1.00	1.00
	Smoker	3.00 (2.12-4.25)**	3.94 (3.11-4.99)**
Cannabis Use	Never used	1.00	1.00
	Ever used	7.76 (6.36-9.46)**	7.12 (5.95-8.52)**
Mental health factors			
Depression	No Depression	1.00	1.00
	Depression (≥10)	1.98 (0.76-5.13)	2.08 (0.92-4.69)
Anxiety	No Anxiety	1.00	1.00
	Anxiety (≥ 10)	0.57 (0.15-2.22)	0.66 (0.20-2.16)
Flourishing	Flourishing Scale (continuous)	0.98 (0.95-1.01)	0.98 (0.96-1.00)
Interactions			
Dep*Anx		0.49 (0.09-2.78)	0.43 (0.10-1.91)
Dep*Flourish		0.98 (0.92-1.03)	0.97 (0.92-1.01)
Anx*Flourish		1.05 (0.96-1.14)	1.04 (0.97-1.13)
Dep*Anx*Flourish		1.02 (0.92-1.13)	1.03 (0.94-1.12)
	Concordance statistic	0.862	0.836

[†] Note: Complete case analysis was conducted and 2395 observations were deleted due to missing data for the mental health and binger drinking variables.

^a Note: Model 1 is a logistic regression of mental health predictors and binge drinking status

^b Note: Model 2 is an ordinal logistic regression of mental health predictors and binge drinking frequency

* p≤0.01, **p<0.001

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Title and abstract	Item No	Recommendation
	1	(a) Indicate the study's design with a commonly used term in the title or the abstract
		Implications of concurrent binge drinking and mental health problems among Canadian youth
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found
		Objective: The objective of this study was to examine the psychosocial correlates of binge drinking among a large sample of Canadian youth, while testing the moderating effect of flourishing on the potential relationship between binge drinking and clinically-relevant symptoms of mental health problems.
		Design: cross-sectional
		Setting: 14 secondary schools across Ontario and British Columbia Canada
		Participants: A sample of grade 9-12 students (n=6570) who participated in the Mental Health pilot of the COMPASS study
		Primary and secondary outcome measures: self-reported questionnaires were completed by students measuring binge drinking and its frequency associated with depression and anxiety symptoms.
		Results: In our sample of 6,570 students, 37.0% of students report binge drink in the last year, and 41.4% of students report clinically relevant symptoms of depression and 31.7% for anxiety. Anxiety (OR: 0.57 [0.15-2.22]) and depression (OR: 1.98 [0.76-5.13]) symptoms were not found to be associated with binge drinking and we did not detect any moderating role of flourishing. Rather, factors that were associated with increased odds of binge drinking included sports team participation (OR: 1.67 [1.37-2.03]) and use of other substances (tobacco (OR: 3.00 [2.12-4.25]) and cannabis (OR: 7.76 [6.36-9.46])). Similar associations were found for frequency of binge drinking.
		Conclusions: Consistent with existing literature, binge drinking behaviours were common, as were sub-clinical symptoms of depression and anxiety. However, mental health problems and wellbeing may not be responsible for explaining patterns of binge drinking in youth. Instead, our findings suggest that alcohol use among youth may be a product of social acceptability and normalcy. Targeted intervention efforts towards student athletes and concurrent substance users are necessary for addressing binge drinking in youth populations.
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
		Developing a robust understanding of the associations between youth binge drinking and mental health would be valuable in helping to inform how different substances may be correlated with mental health and wellbeing.

Binge drinking during adolescence has been linked to negative psychological outcomes including conduct disorder, anxiety, depression, and suicidal behaviour. Depression in youth has been suggested to lead to binge drinking in attempt to reduce negative emotions. Moreover, binge drinking has many negative physiological effects on the brain and may lead to impaired mood and feelings of depression, particularly in children. Given the paucity of available literature on the effects of flourishing, additional research on the influence of overall wellbeing within other substance use domains, such as adolescent binge drinking, is warranted

Objectives	3	State specific objectives, including any prespecified hypotheses
		The objective of this study was to assess the relationship between binge drinking and mental health problems including depression and anxiety among a large sample of Canadian youth. Additionally, we aim to contribute to the literature by examining whether flourishing will moderate the association between mental health problems and binge drinking behaviour within Canadian high school students.
Methods		
Study design	4	Present key elements of study design early in the paper
		The COMPASS Study (COMPASS) is a longitudinal, prospective cohort study (2012-2021) that collects data from students in grades 9 to 12 attending participating secondary schools across Canada. During the COMPASS year 5 (Y ₅ [2016-2017]) data collection, a new module was included to measure student mental health, given that schools participating in the earlier waves of COMPASS identified this as a priority area that was missing from the survey tools. As such, this paper uses the new student-level data collected from students attending 14 COMPASS schools who participated in the MH-M pilot to evaluate the how mental health problems are associated with youth binge drinking.
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
		Data were collected from 8,344 students attending selected secondary schools in British Columbia (N=5) and Ontario (N=9), Canada.
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants
		Students were recruited using a parental active-information passive-consent permission protocol. A complete-case analysis was used for this manuscript (N=8,344), resulting in a final analytic sample of 6,570 students.
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
		Our outcome variable of interest was cannabis ever use (binary) and frequency of use (ordinal [6 categories]). Exposure variables included measures of clinically relevant symptoms of depression and anxiety and were

coded as binary measures based on previously determined thresholds. Flourishing was included as a potential moderator.

Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
		<p><i>Binge Drinking</i></p> <p>Binge drinking was assessed by asking students “In the last 12 months, how often did you have 5 drinks of alcohol or more on one occasion?” Responses were recoded into a binary measure of binge drinking, where students who indicated never having done this, were classified as “non-current binge drinkers” and all other responses were coded as “current binge drinkers.” For ordinal responses, binge drinking frequency was collapsed into the following: “non-current binge drinkers,” consistent with the binary variable explained above; “rare/sporadic,” if respondents indicated binge drinking less than once a month; “monthly,” if reported use was once to 3 times per month, and; “weekly,” if use ranged from once a week to daily.</p>
		<p><i>Mental health variables</i></p> <p>Youth depressive symptoms were assessed using <i>the Center for Epidemiologic Studies Depression Scale (Revised)-10 (CESD-R10)</i>. This 10-item scale was designed to assess self-reported symptoms associated with depression such as feelings of sadness, loss of interest, difficulties sleeping, making decisions, and concentrating over a 1-week period. Anxiety symptoms were measured using the <i>Generalized Anxiety Disorder 7-item Scale (GAD-7)</i>. The GAD-7 reports on self-perceived feelings of worry, fear, and irritability over a 2-week period of time. Both scales have been validated for use in adolescent populations. The CESD-R-10 and GAD-7 scales were fit as dichotomous variables for each model; consistent with other research, this study applied a binary coding system to categorize students with and without clinically relevant symptoms (control=0, depression and/or anxiety=1) using scores ≥ 10 for both depression and anxiety to indicate the presence of mental health problems.</p>
		<p>Levels of psychosocial prosperity and wellbeing among students was measured using <i>the Flourishing Scale (FS)</i>. This scale provides a score that represents overall psychological wellbeing on a flourishing-languishing continuum by assessing how students perceive their: relationships; life purpose and satisfaction; engagement with and interest in daily activities; self-esteem; competence, and; optimism. To remain suitable for large, school-based studies, the original 7-point Likert scale was reduced to a 5-point response option with total scores ranging from 8 to 40. All item statements are positively framed within the original FS.</p>
Bias	9	<p>Describe any efforts to address potential sources of bias</p> <p>Given the nature of self-reported data, the COMPASS study ensures confidentiality of data through autotomized student surveys and utilizes a passive consent protocol to reduce the effects of information bias (social desirability and recall bias) and missing data.</p>

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Study size	10	<p>Explain how the study size was arrived at</p> <p>A complete-case analysis was used for this manuscript (N=8,344), resulting in a final analytic sample of 6,570 students.</p>
Quantitative variables	11	<p>Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why</p> <p><i>Binge drinking</i> (dichotomous dependent variable) was fit using binary logistic models and binge drinking frequency (ordinal dependent variable) was fit using ordinal logistic regression models. The explanatory variables were fit as dichotomous variables using the predetermined thresholds that are used to classify clinically relevant symptoms of depression and anxiety.</p>
Statistical methods	12	<p>(a) Describe all statistical methods, including those used to control for confounding</p> <p>To help with the interpretation of the results, we used a stepwise modeling approach: 1) the main effects of depression and anxiety were tested, 2) flourishing was added and main effects tested, and 3) inclusion of 2-way and 3-way interactions among depression, anxiety, and flourishing to test for moderation/significant interactions.</p> <p>(b) Describe any methods used to examine subgroups and interactions</p> <p>Using a stepwise modeling approach, we were able to evaluate any significant changes and interactions (if any) after including each variable.</p> <p>(c) Explain how missing data were addressed</p> <p>We used a complete case analysis.</p> <p>(d) If applicable, describe analytical methods taking account of sampling strategy</p> <p>N/A</p> <p>(e) Describe any sensitivity analyses</p> <p>In addition to the 2 logistic models reported on, depression and anxiety variables were separately fit as continuous variables in these models to confirm our results, however are not presented in this manuscript.</p>
Results		
Participants	13*	<p>(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed</p> <p>A complete-case analysis was used for this manuscript (N=8,344), resulting in a final analytic sample of 6,570 students.</p> <p>(b) Give reasons for non-participation at each stage</p> <p>Given the cross-sectional nature of this study, there was only one round of data collections (N=6,570). Missing data results from incomplete student surveys.</p> <p>(c) Consider use of a flow diagram</p>

		N/A
Descriptive data	14*	<p>(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders</p> <p>The majority of students reported their ethnicity as white (71.4%) and 51.6% were female. Overall, 37.0% of the sample reported binge drinking at least once within the past year and 20% indicated binge drinking at least once a month. Mental health problems were common within the study sample: 41.4% of students reported clinically relevant symptoms (scores ≥ 10) for depression and 31.7% reported symptoms of anxiety (scores ≥ 10). The mean flourishing score was 16.66 (SD:5.87). Additionally, females were more apt to report depression, anxiety, and lower flourishing levels compared to males. Females were also more likely to be sporadic and monthly binge drinkers and less likely to binge drink weekly compared to males.</p> <p>(b) Indicate number of participants with missing data for each variable of interest</p>
		N/A
Outcome data	15*	<p>Report numbers of outcome events or summary measures</p> <p>Current binge drinkers were more likely to be in grade 10 [OR 1.56, $p < 0.001$], grade 11 [OR 1.69, $p < 0.001$], and grade 12 [OR 2.31, $p < 0.001$]. The same demographic trends were observed for binge drinking frequency, whereby students in older grades were more likely to report higher binge drinking frequencies and the odds of this increased for every grade level. Cannabis use [OR 7.76, $p < 0.001$], tobacco smoking [OR 3.00, $p < 0.001$], truancy [OR 2.29, $p < 0.001$] and being involved on a sports team [OR 1.67, $p < 0.001$] were significantly associated with an increased odds of binge drinking. Similarly cannabis use [OR 7.12, $p < 0.001$], tobacco smoking [OR 3.94, $p < 0.001$], truancy [OR 2.04, $p < 0.001$] and being involved on a sports team [OR 1.64, $p < 0.001$] were associated with increases in binge drinking frequency. Compared to those who reported not having any spending money, youth with \$1-\$20 of weekly spending money were 1.37 times more likely to binge drink and the odds of binge drinking doubled (2.68) for youth with greater than \$100 of weekly spending money.</p>
Main results	16	<p>(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included</p> <p>Sub-clinical symptoms of depression and anxiety and self-reported flourishing were not found to be significantly associated with binge drinking or binge drinking frequency within our sample. Moreover, the addition of interaction terms did not lead to any changes in estimations or significance; therefore, flourishing did not moderate the association between mental health problems and binge drinking behaviours as hypothesized and was not found to be a confounding variable as seen in recent cannabis research.</p> <p>(b) Report category boundaries when continuous variables were categorized</p> <p>Consistent with other research, this study applied a binary coding system to</p>

categorize students with and without clinically relevant symptoms (control=0, depression and/or anxiety=1) using scores ≥ 10 for both depression and anxiety to indicate the presence of mental health problems.

(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period

N/A

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
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N/A

Discussion

Key results	18	Summarise key results with reference to study objectives
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Our results correspond with previous surveillance research and national averages showing alcohol is the most prevalent substance used among Canadian adolescents and identified that almost one third of youth in Ontario and British Columbia, who participated in the COMPASS MH-M pilot study, reported binge drinking within the past 12 months, and almost 1 in 6 students reported this behaviour monthly. Depression and anxiety were also found to be highly prevalent mental health problems among our large sample of youth; nearly one-half of students indicated symptoms of clinically relevant depression and one third reported clinically relevant symptoms of anxiety. Although highly prevalent, depression and anxiety were not associated with binge drinking, and flourishing was not found to be a moderating factor. While recent cannabis research suggest that mental health and wellbeing are associated with youth cannabis use, this research indicates that it is unlikely youth use alcohol for the same reasons as cannabis suggesting substance-specific interventions to be developed.

Our findings provide support for the association between binge drinking patterns and the behavioural influences outlined by Theory of Planned Behaviour, as demonstrated elsewhere. Distal factors of this theory such as socioeconomic status, were also found to be associated with binge drinking among our sample of youth. We identified a strong dose-response relationship between binge drinking and weekly spending money, indicating that socioeconomic status may be correlated with alcohol consumption among youth, whereby greater amounts of weekly spending money was associated with an increased likelihood of binge drinking and binge drinking frequency.

Existing literature indicates the perception of peer alcohol use may be the strongest predictor of adolescent drinking behaviour.⁽¹⁸⁾ Underlying motives for alcohol consumption may represent important insight for intervention strategies given that alcohol consumption is situational and may differ across individuals. This may provide reason for our lack of association found

between mental health problems and binge drinking, and suggests that alcohol consumption may result due to social interaction and establishing relationships with peers. Given the differences in significant predictors for alcohol and cannabis among the same sample of COMPASS participants, it is necessary to consider tailored approaches for each individual substance, rather than developing intervention programs that address the use of many substances simultaneously.

Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
		Since student data are self-reported, findings may be subject to reporting or recall bias, however, passive permission protocols have been implemented to preserve anonymity. Mental health items were measured using scales and were based on 1-2 week recall; as such, these measures are not diagnostic and cannot determine whether symptoms were chronic or short term. Lastly, this study was unable to examine broader social environments that may be associated with alcohol consumption patterns, and was unable to establish binge drinking trajectories in relation to mental health problems given the cross-sectional nature of the data.
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
		A large proportion of the study sample of grade 9-12 students reports binge drinking. While symptoms of depression and anxiety are also highly prevalent in this population, our research shows that they are likely not responsible for explaining patterns of excessive alcohol consumption in our youth sample. Contrary to our hypothesis, flourishing was not shown to moderate the relationship between mental health and binge drinking in high school students. This new analysis of the COMPASS mental health data and alcohol use among youth suggests that binge drinking among youth may be a product of social acceptability and normalcy. Future interventions may consider peer-to-peer mentoring and research should aim to consider the role of social environments and alcohol consumption, and where data is available, targeting binge drinking within a team dynamic and among different types of sports.
Generalisability	21	Discuss the generalisability (external validity) of the study results
		The COMPASS Study was not designed to collect representative data as sampling was purposeful and we used an active-information, passive consent protocol.
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based
		The COMPASS Study, including the Mental Health Module, is supported by funds from the Canadian Institutes of Health Research (CIHR) (PJT-149092; grant awarded to Patte and Leatherdale). The COMPASS study extension

(2016-2021) was supported by a CIHR Project Grant (PJT-148562; grant awarded to Leatherdale). The COMPASS expansion to additional jurisdictions was funded by a Health Canada grant through the Substance Use and Addictions Program (SUAP). The creation of this manuscript was funded by the Research Affiliate Program from the Public Health Agency of Canada, Applied Research Branch

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Psychological correlates and binge drinking behaviours among Canadian youth: a cross-sectional analysis of the mental health pilot data from the COMPASS Study

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Manuscripts

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3 **Psychological correlates and binge drinking behaviours among Canadian youth: a cross-sectional**
4 **analysis of the mental health pilot data from the COMPASS Study**
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ABSTRACT

Objective: The objective of this study was to examine associations between depression, anxiety, and binge drinking among a large sample of Canadian youth, while testing the moderating effect of flourishing. This research uses data from the COMPASS study (2012-2021) with a large sample size collecting data on youth health behaviours within Canadian secondary schools.

Design: Cross-sectional

Setting: 14 secondary schools across Ontario and British Columbia, Canada.

Participants: A sample of grade 9-12 students (n=6570) who participated in the Mental Health pilot of the COMPASS study

Primary and secondary outcome measures: Self-reported questionnaires assessed student binge drinking behaviours (5 ≥ drinks), symptoms of depression (CESD-R-10 scores ≥ 10) and anxiety (GAD-7 scores ≥ 10), and flourishing (Diener's Flourishing Scale: 8-40).

Results: In our sample of 6,570 students, 37.0% of students reported binge drinking in the last year, and 41.4% and 31.7% of students report clinically-relevant symptoms of depression and anxiety, respectively. Anxiety (AOR: 0.57, 99% CI [0.15-2.22]) and depression (AOR: 1.98, 99% CI [0.76-5.13]) symptoms were not found to be associated with binge drinking and we did not detect any moderating role of flourishing. Rather, factors that were associated with increased odds of binge drinking included sports team participation (AOR: 1.67, 99% CI [1.37-2.03]) and use of other substances [tobacco (AOR: 3.00, 99% CI [2.12-4.25]) and cannabis (AOR: 7.76, 99% CI [6.36-9.46])]. Similar associations were found for frequency of binge drinking.

Conclusions: Consistent with existing literature, binge drinking behaviours were problematic, as well as clinically-relevant symptoms of depression and anxiety. However, mental health problems and wellbeing may not be responsible for explaining patterns of binge drinking in youth. Targeted intervention efforts towards student athletes and concurrent substance users are necessary for addressing binge drinking in youth populations.

Article Summary

Strengths and Limitations

- The COMPASS project is a unique data system that provides an ideal platform to evaluate multiple co-occurring behavioural trajectories among a large sample of Canadian youth.
- Only cross-sectional results are reported as this study used first year pilot data for a mental health module to examine associations between mental health problems and binge drinking; future waves of COMPASS will allow mental health trajectories to be explored.
- Purposive sampling methods were used and results may not be representative of all Ontario and British Columbia secondary schools.
- Although findings may be subject to reporting or recall bias as data were self-reported, passive permission protocols and unique self-generated identification codes have been implemented to preserve anonymity.
- This study was unable to examine broader social environments (e.g., social acceptability of alcohol, sport team dynamics) that may be associated with alcohol consumption patterns.

Introduction

Although federal and provincial legislations in Canada prohibit alcohol consumption for those under the age of 18 or 19, about 25% of Canadian students in grade 7 to 12 report past-year binge drinking, which has been previously operationalized as consuming five or more drinks on one occasion.(1,2) In comparison, 17% of youth report past-year cannabis use and 10% report using tobacco products in the past-30-days.(2) Acute and chronic health risks of early-onset alcohol use can be severe, including potential neurologic and psychosocial concerns. As brain development continues throughout adolescence, youth are especially vulnerable to the effects of alcohol, particularly in high volumes and frequent doses.(3,4) Alcohol consumption during adolescence may contribute to future experiences of psychiatric and substance use disorders (3,5), and youth who partake in binge drinking are at increased risk for such adverse health outcomes compared to youth who do not.(6–9) Binge drinking (10,11) and frequency of drunkenness (12) during adolescence have been linked to negative psychological outcomes including conduct disorder, anxiety, depression, and suicidal behaviour. Binge drinking has many negative physiological effects on the brain (13) and may lead to impaired mood and symptoms of depression among youth.(14,15) Longitudinal research has found problem-use of alcohol during adolescence to be predictive of depression in young adulthood.(14) Alternatively, depression has been found predict subsequent alcohol use, and research suggests that youth who experience depressive symptoms may binge drink in attempt to reduce negative affect.(16,17) Negative affect is a strong predictor of harmful drinking and may distinguish between customary or social drinking behaviours, and abusive drinking trajectories.(18)

Widespread alcohol use among youth may also be explained by the *Theory of Planned Behaviour*.(19) The Theory of Planned Behaviour is a psychosocial model that has been effectively applied to the prediction of many health behaviours by considering an individual's attitude, subjective norms, and perceived behavioural control.(19) Within Canada, alcohol is generally recognized as a socially acceptable and popular substance.(1) Research suggests normative social influences and cultural norms may also play an important role in explaining drinking patterns.(20,21) Given this, behaviours may result from interactions with surrounding social environments and contribute to the development of positive perceptions of drinking.(22–24) These positive perceptions can create an environment where drinking behaviour is both accepted and encouraged socially, and may contribute to increased alcohol consumption and binge drinking.(22,25,26) Despite the potential hazardous health outcomes and biopsychosocial problems associated with binge drinking (13), it is often viewed as a positive social activity; an important aspect to consider when exploring the relationship between drinking and mental wellbeing. One study found that drinking with friends is protective against alcohol-related problems (e.g., physical fights or injuries, driving under the influence, hangovers or vomiting).(27) As such, research has suggested that social drinking may coincide with aspects of positive psychosocial wellbeing such as social participation, enhanced self-esteem and autonomy, coping strategies, and accountability.(28)

Flourishing is the presence of positive mental health, inclusive of emotional, psychological, and social prosperity, and often used as an indicator of overall psychosocial wellbeing.(29–31) Flourishing incorporates contemporary theories of wellbeing, acknowledging the importance of social relationships, not just for pleasure but self-perceived interest and engagement, and meaning and purpose in life. New research suggests flourishing may offer protective effects, moderating the relationship between mental health problems and cannabis use.(32) After controlling for depression and anxiety, youth who reported flourishing were found to be less likely to have used cannabis and less likely to have used at higher frequencies.(32) Additional research on the influence of overall wellbeing within other substance use

domains, such as binge drinking, is necessary. The authors are unaware of existing research that has evaluated indicators of mental wellbeing, such as flourishing, as a protective factor against binge drinking and mental health problems among youth. In response to this gap, the objective of the current study was to examine the association between binge drinking and depression and anxiety symptoms among a large sample of Canadian youth. Additionally, we aim to contribute to the literature by examining whether flourishing moderates the association between depression, anxiety, and binge drinking behaviour within Canadian secondary school students.

Methods

The COMPASS Study is a prospective cohort study (2012-2021) that collects data from full school samples of students in grades 9 through 12 attending participating secondary schools across Canada.⁽³³⁾ A new COMPASS mental health module (MH-M) was piloted in year 5 COMPASS data collections (Y₅[2016-2017]), as students' mental health was identified by stakeholders as a priority area for study.⁽³⁴⁾ This paper uses the data collected from students attending the 14 COMPASS schools that were selected to participate in the MH-M pilot via the COMPASS student questionnaire.⁽³⁴⁾ The original COMPASS study protocol was maintained with the exception of the eight new subsections about youth mental health that were added to supplement the original student questionnaire.^(33,35,36) A complete description of COMPASS methods is available in print ⁽³³⁾ or online (www.compass.uwaterloo.ca). This study received ethics approval from the University of Waterloo Human Research Ethics Committee and all participating school boards.

Data were collected from 8,344 students attending selected secondary schools in British Columbia (N=5) and Ontario (N=9), Canada. Specific schools were recruited to participate in the pilot stage of the mental health module during year 5 of the COMPASS data collection based on expressed interest in the mental health data. Students were recruited using a parental active-information passive-consent permission protocol ⁽³³⁾, a strategy shown to be important for collecting robust data on self-reported risk behaviours such as substance use among youth.⁽³⁷⁻³⁹⁾ A complete-case analysis was used for this manuscript (N=8,344), resulting in a final analytic sample of 6,570 students.

Patient and public involvement

There were no patients involved in the development of the research study. School board stakeholders were involved throughout the development of the pilot mental health module as part of the working research team. Anonymized school-, board- and province-level results were prepared for applicable stakeholders in the form of a report. See www.compass.uwaterloo.ca for protocol details.

Measures

Binge Drinking

Consistent with previous research ⁽⁴⁰⁾, binge drinking was assessed by asking students "In the last 12 months, how often did you have 5 drinks of alcohol or more on one occasion?" Responses were recoded into a binary measure of binge drinking, where students who indicated not having done this in the past 12 months, were classified as "non-current binge drinkers" and all other responses were coded as "current binge drinkers." For ordinal responses, binge drinking frequency was collapsed into the following: "non-current binge drinkers," consistent with the binary variable explained above; "rare/sporadic," if respondents indicated binge drinking less than once a month; "monthly," if reported use was once to 3 times per month, and; "weekly," if use ranged from once a week to daily.

Mental health variables

Youth depressive symptoms were assessed using the *Center for Epidemiologic Studies Depression Scale (Revised)-10* (CESD-R-10; (41)). This 10-item scale was designed to assess self-reported symptoms characteristic of depression such as feelings of sadness, hopelessness, apathy and motivation, irritability, and difficulties sleeping, making decisions, and concentrating over a 1-week period.(41–43) Internal consistency of the CESD-R-10 scale was high ($\alpha=0.98$). Anxiety symptoms were measured using the *Generalized Anxiety Disorder 7-item Scale* (GAD-7; (44)). The GAD-7 assesses on difficulty controlling feelings of worry, trouble relaxing, nervousness, restlessness, and irritability over a 2-week period of time and had high internal consistency ($\alpha=0.99$). Both scales have been validated for use in adolescent populations.(42–44) The CESD-R-10 and GAD-7 scales were fit as dichotomous variables for each model; consistent with other research, this study applied a binary coding system to categorize students with and without clinically-relevant symptoms (control=0, depression and/or anxiety=1) using scores ≥ 10 for both the CESD-R-10 (41,43) and GAD-7 (44) to indicate risk of or probable depression and anxiety, respectively.

Levels of self-perceived psychosocial wellbeing among students was measured using *Diener's Flourishing Scale (FS; (45))*. This scale provides a score that represents overall psychological functioning on a flourishing-languishing continuum by assessing how students perceive their: relationships, life purpose and satisfaction, engagement with and interest in daily activities, self-esteem, competence, and optimism. To remain suitable for large, school-based studies (36), the original 7-point Likert scale was reduced to a 5-point response option with total scores ranging from 8 to 40. All item statements are positively framed within the original FS.(45) However, to remain consistent with the other COMPASS MH-M measures, the FS was reverse coded where low scores represented flourishing (good overall wellbeing) and high scores represent languishing (an indication of poor overall psychosocial wellbeing). Internal consistency of the FS was high ($\alpha= 0.98$).

Covariates

Existing knowledge indicates that adolescent males may be most likely to participate in binge drinking behaviour.(7) Harmful health behaviours have been shown to cluster together in adolescence, indicating a propensity in binge drinkers to be concurrent tobacco and cannabis users.(46) Previous studies have cited risk-taking behaviour (47), unhealthy weight-control methods (48), and participation in team sports (49) as common binge drinking risk factors among secondary school students. The following covariates were accounted for: grade (9, 10, 11, 12); sex (female, male); ethnicity (White, Black, Asian, Indigenous [First Nations, Métis, Inuit], Latin American or Hispanic, Mixed/Other); weekly spending money (\$0, \$1-\$20, \$21-\$100, more than \$100, I don't know; as a proxy for socioeconomic status, as this is a more accessible value for youth to report on than household income); truancy (no skipped classes, 1 or more missed classes per week); cannabis use (never use, ever user [ever using marijuana]); smoking status (non-smoker [reported never smoking or non-current use of cigarettes], current smoker [reported smoking one or more cigarettes in the past month]) and team sport involvement (not involved, involved [school- or community-level]).

Analysis

Among our analytic sample, descriptive analyses were conducted using χ^2 and *t* tests. Binge drinking status (non-current vs current binge drinker) was modelled using a binary logistic regression (model 1) and binge drinking frequency was modelled using an ordinal logistic regression (model 2) which adjusted for relevant covariates. Given the large sample size, a confidence interval of 99% was used. The frequency of binge drinking was modeled to examine if mental health problems were associated with increasing levels of binge drinking frequencies. To examine flourishing as a moderating variable, 2- and 3-way interactions between flourishing, depression and anxiety were tested. Only

complete-case analysis was conducted where 11% of GAD-7 data, 18% of CESD-R-10 data and less than 1% of binge drinking was missing. The impact of data was assessed and we found no meaningful difference among students with and without missing data. All analyses were conducted in SAS 9.4.(50)

Results

Sample characteristics

Demographic characteristics for the total sample (n=6,570) are presented in Table 1. The majority of students reported their ethnicity as white (71.4%) and 51.6% were female. Overall, 37.0% of the sample reported binge drinking at least once within the past year and 20% indicated binge drinking at least once a month. Clinically-relevant symptoms (scores ≥ 10) for depression were reported by 41.4% of students in the sample and 31.7% reported symptoms of anxiety above the threshold (scores ≥ 10). The mean flourishing score was 16.66 (SD:5.87) and after examining descriptive results by sex, females (17.23 [SD:6.00]) reported greater languishing scores than males (15.99 [SD:5.65]). More females reported clinically-relevant symptoms of depression (51.9% vs 30.1%) and anxiety (43.5% vs 19.1%), compared to their male counterparts. Although the rate of binge drinking among females and males was similar, females were more likely to engage in sporadic (18.7% vs 15.3%) and monthly (15.2% vs 14.6%) binge drinking and less likely to binge drink weekly (3.9% vs 6.3%), compared to males.

Correlates of drinking behaviours

Table 2 demonstrates results of the regression models used for predicting binge drinking behaviours. Youth reporting current binge drinking were more likely to be in grade 12 [AOR 2.31, 99% CI 1.74-3.02], grade 11 [AOR 1.69, 99% CI 1.29-2.20], and grade 10 [AOR 1.56, 99% CI 1.21-2.00] in Model 1. The same demographic trends were observed in Model 2 for binge drinking frequency, whereby students in older grades were more likely to report higher binge drinking frequencies. As seen in Model 1, cannabis use [AOR: 7.76, 99% CI 6.36-9.46], tobacco smoking [AOR 3.00, 99% CI 2.12-4.25], truancy [AOR 2.29, 99% CI 1.90-2.76] and being involved with a sports team [AOR 1.67, 99% CI 1.37-2.03] were significantly associated with an increased odds of binge drinking. Similarly, cannabis use [AOR 7.12, 99% CI 5.95-8.52], tobacco smoking [AOR 3.94, 99% CI 3.11-4.99], truancy [AOR 2.04, 99% CI 1.73-2.41] and being involved on a sports team [AOR 1.64, 99% CI 1.39-1.93] were associated with increases in binge drinking frequency in Model 2. Compared to those who reported not having any spending money, youth with \$1-\$20 of weekly spending money were 1.37 times more likely to binge drink and the odds of binge drinking doubled (AOR: 2.68) for youth with greater than \$100 of weekly spending money (Model 1). Although mental health indicators were not found to be statistically significant, directionality of the adjusted odds ratios suggests a potentially positive association between depression and binge drinking [AOR: 1.98, 99% CI 0.76-5.13], as well as a negative association between anxiety and binge drinking [AOR: 0.57, 99% CI 0.15-2.22].

Moderating effects of flourishing

Above-threshold symptoms of depression and anxiety, and self-reported flourishing were not found to be significantly associated with binge drinking or binge drinking frequency within our sample. Moreover, the addition of interaction terms did not lead to any changes in estimations or significance; therefore, flourishing did not moderate the association between depression or anxiety symptoms and binge drinking behaviours as hypothesized.

Discussion

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4 Our findings correspond with previous surveillance research and national averages showing
5 alcohol is the most common substance used among our sample of Canadian adolescents.(1,2) This study
6 identified that more than one-third of youth in Ontario and British Columbia, Canada who participated
7 in the COMPASS MH-M pilot study, reported binge drinking within the past 12 months, and almost 1 in 6
8 students reported this behaviour monthly. Within our large sample of youth, nearly one-half of students
9 indicated symptoms of clinically-relevant depression and one-third reported clinically-relevant
10 symptoms of anxiety. Consistent with other research (51) as well as existing findings from the COMPASS
11 MH-M pilot study (32), neither depression nor anxiety were correlated with binge drinking. However,
12 unlike previous COMPASS research that found flourishing may protect against cannabis use (32), these
13 corresponding association were not observed within this study for binge drinking. Based on these
14 findings, youth may use alcohol for different reasons than cannabis, suggesting the two substances may
15 play distinct social and psychological roles.
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18 As literature continues to present inconsistent findings between mental health and substance
19 use, it is critical to acknowledge subgroups of consumers (18,52) as underlying motives for alcohol
20 consumption may represent important insight for intervention strategies.(53) In Canada, alcohol
21 consumption exists as a normative social behaviour (54) that is common to many population(1),
22 including youth.(20,21,24) This custom may provide reason for the lack of associations observed in this
23 study, and suggests that alcohol consumption may more commonly occur as a social activity rather than
24 a coping mechanism for negative affect, attenuating potential associations between mental health
25 problems and binge drinking. Such links between social influence and binge drinking have also been
26 demonstrated elsewhere (55–58) and ultimately provide support for the *Theory of Planned Behaviour*.
27 Schlegel et al. (58) found attitudes towards binge drinking and perceived social norms all contributed to
28 the intention and frequency of binge drinking. Moreover, binge drinking in youth has been shown to be
29 associated with peer group influences, whereby peer alcohol use may be the strongest predictor of
30 adolescent drinking behaviour, presenting important implications for intervention approaches.(20,59)
31 Distal components of this theory, such as socioeconomic status, were also found to be associated with
32 binge drinking in our sample. We identified a strong dose-response relationship between binge drinking
33 and weekly spending money, with greater amounts of weekly spending money predicting an increased
34 likelihood of binge drinking and binge drinking frequency. Our results may reflect a correlation between
35 socioeconomic status and alcohol consumption among youth, or at least appear to indicate that
36 available spending money (e.g., provided by parental, part-time employment, or other sources) provides
37 the means to purchase alcohol.
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41 These findings supplement other substance use literature and identify that co-occurring
42 substance use is common among students who binge drink.(60–63) Youth engaging in current binge
43 drinking were approximately three times more likely to smoke tobacco and almost eight times more
44 likely to use cannabis. Sports team participation appeared to also be a strong predictor of binge
45 drinking. Adding this variable improved the predictive accuracy of our logistic models, as demonstrated
46 by the concordance statistic. While sports team participation can contribute to positive health
47 behaviours among youth (e.g. physical activity), patterns of excessive alcohol consumption among
48 school athletes has been previously observed in research.(64)
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51 The Canadian Centre on Substance Abuse recognizes that sports participation is linked to
52 decreases in illicit drug use among youth, but the use of alcohol increases.(65) Youth between the ages
53 of 15 to 19 years have the highest participation rates in sports.(66) Athletic involvement presents an
54 optimal opportunity to influence youth by leveraging their team sport environments and implementing
55 targeted prevention strategies.(65) Substance use is commonly initiated during adolescence, where
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3 enrolment in sports is high, and as such, this is a critical period for substance use prevention efforts.(67)
4 For instance, public health authorities may consider limiting or restricting alcohol promotion during
5 events that may be attended by youth. Continued research is necessary within this domain as there
6 remains a paucity of evidence on the risk of binge drinking within a team dynamic.
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9 Given the varied predictors for alcohol and cannabis use among youth in the COMPASS MH-M
10 pilot study, tailored approaches for each individual substance may be necessary. Although statistically
11 insignificant, our findings present interesting results that suggest depression and anxiety may have
12 different outcomes for alcohol consumption, and the directionality of associations observed may
13 provide insight to public health researchers. Based heavily on the Theory of Planned Behaviour, existing
14 psychosocial research suggests that persuading attitudes and norms to influence behaviour may prove
15 effective at producing long-term changes.(68) Successful strategies may involve peer-to-peer mentoring
16 or social norming campaigns given the influence peer groups have on attitudes towards alcohol
17 consumption and, in turn, binge drinking behaviour.(20,21,24) Also, targeted intervention efforts
18 implemented within the environment of a sports team dynamic may effectively influence health
19 behaviours. Research should aim to examine substance use behaviours both separately and
20 concurrently; further exploration may consider the possible association between mental health and co-
21 occurring alcohol and cannabis use. Future waves of the COMPASS Study will be able to test these
22 correlations and temporal relationships.
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25 *Strengths and Limitations*

26 The COMPASS Study is a unique data system that examines Canadian youth risk behaviours, and
27 provides an ideal platform to evaluate multiple co-occurring behaviours and changes over time. Our
28 results supplement existing evidence and advance knowledge on youth binge drinking behaviours.
29 Important correlates identified in this study can be used to inform the creation of effective prevention
30 and intervention programs. While this study provides a novel contribution to the literature, it is not
31 without limitations. COMPASS uses a purposeful sampling method, and results are not representative of
32 all Ontario and British Columbia youth or secondary schools. Since student data are self-reported,
33 findings may be subject to reporting or recall bias, however, passive permission protocols have been
34 implemented to improve sample representativeness and preserve anonymity. By employing a complete-
35 case analysis, associations observed within this study may be underestimated. Data appeared to missing
36 at random and information bias from non-differential misclassification is possible. Mental health items
37 were measured based on 1-2 week recall and although scales employed in this study have been widely
38 validated, these measures cannot be determine whether symptoms were chronic or acute. Moreover,
39 depression and anxiety data were measured using scales and not diagnostic criteria. This study was
40 unable to examine broader social environments (e.g., social acceptability of alcohol, sport team
41 dynamics) that may be associated with alcohol consumption patterns. Lastly, we were unable to
42 establish binge drinking trajectories in relation to depression and anxiety given the cross-sectional
43 nature of the data. As COMPASS employs a longitudinal study design, follow-up research and
44 examination of how behaviours evolve over time is possible once future waves of mental health data
45 become available.
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50 *Conclusion*

51 A large proportion of the study sample of grade 9 to 12 students reported binge drinking. About
52 one-half and one-third of students reports clinically-relevant symptoms of depression and anxiety
53 respectively, however, our research shows that mental health problems were likely not responsible for
54 explaining patterns of alcohol consumption in our youth sample. Contrary to other COMPASS research
55 on cannabis use, flourishing was not shown to moderate the relationship between depression or anxiety
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3 and binge drinking in secondary school students. This new analysis of the COMPASS mental health data
4 and youth alcohol use suggests that binge drinking among youth may be a product of social acceptability
5 and normalcy, as opposed to a coping mechanism or contributor to mental health problems. Future
6 research should aim to consider the role of social environments and alcohol consumption among youth,
7 and where data is available, targeting binge drinking within a team dynamic and among different types
8 of sports.
9

10 11 12 13 *Declarations*

14 15 **Ethics approval and consent to participate**

16 The COMPASS Study received ethics approval from the University of Waterloo Office of Research Ethics
17 as well as participating school boards (ORE #: 30118).
18

19 20 **Consent for publication**

21 Using an active-information, passive-consent protocol, all participants gave consent for the use of their
22 anonymous data.
23

24 25 **Data statement:**

26 A data request form to access to the COMPASS data can be found at: [https://uwaterloo.ca/compass-](https://uwaterloo.ca/compass-system/information-researchers/data-usage-application)
27 [system/information-researchers/data-usage-application](https://uwaterloo.ca/compass-system/information-researchers/data-usage-application)
28

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38

39 40 **Authors' contributions**

41 AEB and IR conceived the manuscript idea, performed the statistical analyses, drafted the manuscript,
42 and revised the manuscript for content. IR, MAF, KAP, MG, and YJ revised the manuscript for critical
43 content. STL conceived the host study, led the acquisition of all data, drafted components of
44 introduction and discussion, and revised the manuscript for critical content. All authors that have
45 contributed significantly to the work presented within this manuscript have been listed above.
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Table 1. Sample descriptives by sex for grade 9-12 students in year 5 of the mental health pilot of COMPASS (2016-2017)

		Total N=6570	Female N=3389	Male N=3181	
		% (n) †	% (n) †	% (n) †	Chi-Square (p-value)
Grade	9	27.9 (1833)	26.9 (913)	28.9 (920)	5.18 (0.16)
	10	29.3 (1923)	30.1 (1021)	28.4 (902)	
	11	24.3 (1597)	24.0 (812)	24.7 (785)	
	12	18.5 (1217)	19.0 (643)	18.0 (574)	
Ethnicity	White	71.4 (4476)	71.3 (2314)	71.5 (2162)	29.49 (<0.0001)
	Indigenous	2.2 (135)	2.0 (66)	2.3 (69)	
	Asian	10.3 (645)	10.6 (343)	9.9 (302)	
	Black	2.5 (156)	1.9 (60)	3.2 (96)	
	Latin American	2.6 (164)	2.0 (65)	3.3 (99)	
	Other/Mixed	11.0 (694)	12.2 (396)	9.8 (298)	
Province	Ontario	57.1 (3749)	56.7 (1920)	57.5 (1829)	0.48 (0.49)
	British Columbia	42.9 (2821)	43.3 (1469)	42.5 (1352)	
Weekly spending money	\$0	15.3 (1004)	13.4 (451)	17.5 (553)	54.93 (<0.0001)
	\$1-\$20	26.8 (175)	27.4 (924)	26.2 (829)	
	\$21-\$100	25.2 (1650)	27.0 (913)	23.3 (737)	
	>\$100	20.1 (1318)	18.2 (614)	22.2 (704)	
	I don't know	12.6 (820)	14.0 (476)	10.8 (344)	
Varsity/community sport involvement	No	67.1 (4377)	71.4 (2398)	62.6 (1979)	56.92 (<0.0001)
	Yes	32.9 (2145)	28.6 (962)	37.4 (1183)	
Truancy	No skipped classes	59.8 (3898)	58.2 (1954)	61.6 (1944)	7.93 (0.005)
	1 or more	40.2 (2619)	41.8 (1406)	38.4 (1213)	
Depression	No depression	58.6 (3852)	48.1 (1629)	69.9 (2223)	321.98 (<0.0001)
	Depression (CESD-R-10 ≥ 10)	41.4 (2718)	51.9 (1760)	30.1 (958)	
Anxiety	No Anxiety	68.3 (4488)	56.5 (1915)	80.9 (2573)	450.55 (<0.0001)
	Anxiety (GAD-7 ≥ 10)	31.7 (2082)	43.5 (1474)	19.1 (608)	
Flourishing (8-40)	Mean Score (SD)	16.63 (5.87)	17.23 (6.00)	15.99 (5.65)	tValue=8.54 (<0.0001)
Smoking status	Non-smoker	89.5 (5864)	89.8 (3036)	89.2 (2828)	0.65 (0.42)
	Smoker	10.5 (688)	10.2 (345)	10.8 (343)	
Cannabis Use	Never used	67.6 (4421)	67.7 (2287)	67.5 (2134)	0.02 (0.88)
	Ever used	32.4 (2117)	32.3 (1091)	32.5 (1026)	
Binge drinking status	Non-current binge drinker	63.0 (4137)	62.2 (2109)	63.7 (2028)	1.63 (0.20)
	Binge drinker	37.0 (2433)	37.8 (1280)	36.3 (1153)	
Binge drinking frequency	Non-current binge drinker	63.0 (4137)	62.2 (2109)	63.8 (2028)	29.27 (<0.0001)
	Rare/sporadic	17.0 (1120)	18.7 (631)	15.3 (489)	
	Monthly	14.9 (980)	15.2 (516)	14.6 (464)	
	Weekly	5.1 (333)	3.9 (133)	6.3 (200)	

† Note: The numbers may not add up to the total due to missing values and rounding. Complete case analysis was conducted; 11% of GAD-7 data, 18% of CESD-R-10 data, and less than 1% of binge drinking data was missing.

Table 2. Binge drinking for grade 9-12 students in year 5 of the COMPASS MH-M (2016-2017)

		Model 1 ^a	Model 2 ^b
		AOR (99%CI) [†]	AOR (99%CI) [†]
Sex	Female	1.00	1.00
	Male	0.94 (0.78-1.14)	1.09 (0.93-1.28)
Grade	9	1.00	1.00
	10	1.56 (1.21-2.00)**	1.51 (1.20-1.89)**
	11	1.69 (1.29-2.20)**	1.62 (1.28-20.6)**
	12	2.31 (1.74-3.07)**	2.13 (1.66-2.73)**
Ethnicity	White	1.00	1.00
	Indigenous	0.84 (0.45-1.57)	0.90 (0.55-1.47)
	Asian	0.47 (0.33-0.68)*	0.53 (0.38-0.73)*
	Black	0.63 (0.35-1.13)	1.07 (0.66-1.72)
	Latin American	1.05 (0.60-1.14)	0.96 (0.59-1.56)
	Other/Mixed	0.86 (0.64-1.14)	0.92 (0.72-1.17)
Province	Ontario	1.00	1.00
	British Columbia	0.81 (0.67-0.98)*	0.86 (0.73-1.01)
Weekly spending money	\$0	1.00	1.00
	\$1-\$20	1.37 (1.00-1.87)*	1.25 (0.94-1.67)
	\$21-\$100	2.45 (1.80-3.35)**	2.12 (1.60-2.80)**
	>\$100	2.68 (1.93-3.71)**	2.34 (1.88-2.90)**
	I don't know	1.56 (1.08-2.25)*	1.50 (1.17-1.93)*
Varsity/community sport involvement	No	1.00	1.00
	Yes	1.67 (1.37-2.03)**	1.64 (1.39-1.93)**
Truancy	No skipped classes	1.00	1.00
	1 or more	2.29 (1.90-2.76)**	2.04 (1.73-2.41)**
Smoking status	Non-smoker	1.00	1.00
	Smoker	3.00 (2.12-4.25)**	3.94 (3.11-4.99)**
Cannabis Use	Never used	1.00	1.00
	Ever used	7.76 (6.36-9.46)**	7.12 (5.95-8.52)**
Mental health factors			
Depression	No Depression	1.00	1.00
	Depression (CESD-R-10 ≥10)	1.98 (0.76-5.13)	2.08 (0.92-4.69)
Anxiety	No Anxiety	1.00	1.00
	Anxiety (GAD-7 ≥10)	0.57 (0.15-2.22)	0.66 (0.20-2.16)
Flourishing	Flourishing Scale (continuous)	0.98 (0.95-1.01)	0.98 (0.96-1.00)
Interactions			
Depression*Anxiety		0.49 (0.09-2.78)	0.43 (0.10-1.91)
Depression*Flourishing		0.98 (0.92-1.03)	0.97 (0.92-1.01)
Anxiety*Flourishing		1.05 (0.96-1.14)	1.04 (0.97-1.13)
Depression*Anxiety*Flourishing		1.02 (0.92-1.13)	1.03 (0.94-1.12)
Concordance statistic		0.862	0.836

[†] Note: Complete case analysis was conducted and 2395 observations were deleted due to missing data for the mental health and binger drinking variables.
^a Note: Model 1 is a logistic regression of mental health predictors and binge drinking status
^b Note: Model 2 is an ordinal logistic regression of mental health predictors and binge drinking frequency

* p≤0.01, **p<0.001

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Item No	Item No	Recommendation
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract
		Psychological correlates and binge drinking behaviours among Canadian youth: a cross-sectional analysis of the mental health pilot data from the COMPASS Study
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found
		Objective: The objective of this study was to examine the psychosocial correlates of binge drinking among a large sample of Canadian youth, while testing the moderating effect of flourishing on the potential relationship between binge drinking and clinically-relevant symptoms of mental health problems.
		Design: cross-sectional
		Setting: 14 secondary schools across Ontario and British Columbia Canada
		Participants: A sample of grade 9-12 students (n=6570) who participated in the Mental Health pilot of the COMPASS study
		Primary and secondary outcome measures: self-reported questionnaires were completed by students measuring binge drinking and its frequency associated with depression and anxiety symptoms.
		Results: In our sample of 6,570 students, 37.0% of students report binge drink in the last year, and 41.4% of students report clinically relevant symptoms of depression and 31.7% for anxiety. Anxiety (OR: 0.57 [0.15-2.22]) and depression (OR: 1.98 [0.76-5.13]) symptoms were not found to be associated with binge drinking and we did not detect any moderating role of flourishing. Rather, factors that were associated with increased odds of binge drinking included sports team participation (OR: 1.67 [1.37-2.03]) and use of other substances (tobacco (OR: 3.00 [2.12-4.25]) and cannabis (OR: 7.76 [6.36-9.46])). Similar associations were found for frequency of binge drinking.
		Conclusions: Consistent with existing literature, binge drinking behaviours were common, as were sub-clinical symptoms of depression and anxiety. However, mental health problems and wellbeing may not be responsible for explaining patterns of binge drinking in youth. Instead, our findings suggest that alcohol use among youth may be a product of social acceptability and normalcy. Targeted intervention efforts towards student athletes and concurrent substance users are necessary for addressing binge drinking in youth populations.
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
		Developing a robust understanding of the associations between youth binge drinking and mental health would be valuable in helping to inform how

different substances may be correlated with mental health and wellbeing. Binge drinking during adolescence has been linked to negative psychological outcomes including conduct disorder, anxiety, depression, and suicidal behaviour. Depression in youth has been suggested to lead to binge drinking in attempt to reduce negative emotions. Moreover, binge drinking has many negative physiological effects on the brain and may lead to impaired mood and feelings of depression, particularly in children. Given the paucity of available literature on the effects of flourishing, additional research on the influence of overall wellbeing within other substance use domains, such as adolescent binge drinking, is warranted

Objectives	3	State specific objectives, including any prespecified hypotheses
		The objective of this study was to assess the relationship between binge drinking and mental health problems including depression and anxiety among a large sample of Canadian youth. Additionally, we aim to contribute to the literature by examining whether flourishing will moderate the association between mental health problems and binge drinking behaviour within Canadian high school students.
Methods		
Study design	4	Present key elements of study design early in the paper
		The COMPASS Study (COMPASS) is a longitudinal, prospective cohort study (2012-2021) that collects data from students in grades 9 to 12 attending participating secondary schools across Canada. During the COMPASS year 5 (Y ₅ [2016-2017]) data collection, a new module was included to measure student mental health, given that schools participating in the earlier waves of COMPASS identified this as a priority area that was missing from the survey tools. As such, this paper uses the new student-level data collected from students attending 14 COMPASS schools who participated in the MH-M pilot to evaluate the how mental health problems are associated with youth binge drinking.
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
		Data were collected from 8,344 students attending selected secondary schools in British Columbia (N=5) and Ontario (N=9), Canada.
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants
		Students were recruited using a parental active-information passive-consent permission protocol. A complete-case analysis was used for this manuscript (N=8,344), resulting in a final analytic sample of 6,570 students.
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
		Our outcome variable of interest was cannabis ever use (binary) and frequency of use (ordinal [6 categories]). Exposure variables included

measures of clinically relevant symptoms of depression and anxiety and were coded as binary measures based on previously determined thresholds. Flourishing was included as a potential moderator.

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Data sources/
measurement

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For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group

Binge Drinking

Binge drinking was assessed by asking students "In the last 12 months, how often did you have 5 drinks of alcohol or more on one occasion?" Responses were recoded into a binary measure of binge drinking, where students who indicated never having done this, were classified as "non-current binge drinkers" and all other responses were coded as "current binge drinkers." For ordinal responses, binge drinking frequency was collapsed into the following: "non-current binge drinkers," consistent with the binary variable explained above; "rare/sporadic," if respondents indicated binge drinking less than once a month; "monthly," if reported use was once to 3 times per month, and; "weekly," if use ranged from once a week to daily.

Mental health variables

Youth depressive symptoms were assessed using *the Center for Epidemiologic Studies Depression Scale (Revised)-10 (CESD-R10)*. This 10-item scale was designed to assess self-reported symptoms associated with depression such as feelings of sadness, loss of interest, difficulties sleeping, making decisions, and concentrating over a 1-week period. Anxiety symptoms were measured using the *Generalized Anxiety Disorder 7-item Scale (GAD-7)*. The GAD-7 reports on self-perceived feelings of worry, fear, and irritability over a 2-week period of time. Both scales have been validated for use in adolescent populations. The CESD-R-10 and GAD-7 scales were fit as dichotomous variables for each model; consistent with other research, this study applied a binary coding system to categorize students with and without clinically relevant symptoms (control=0, depression and/or anxiety=1) using scores ≥ 10 for both depression and anxiety to indicate the presence of mental health problems.

Levels of psychosocial prosperity and wellbeing among students was measured using *the Flourishing Scale (FS)*. This scale provides a score that represents overall psychological wellbeing on a flourishing-languishing continuum by assessing how students perceive their: relationships; life purpose and satisfaction; engagement with and interest in daily activities; self-esteem; competence, and; optimism. To remain suitable for large, school-based studies, the original 7-point Likert scale was reduced to a 5-point response option with total scores ranging from 8 to 40. All item statements are positively framed within the original FS.

Bias

9

Describe any efforts to address potential sources of bias

Given the nature of self-reported data, the COMPASS study ensures confidentiality of data through automated student surveys and utilizes a passive consent protocol to reduce the effects of information bias (social

		desirability and recall bias) and missing data.
Study size	10	<p>Explain how the study size was arrived at</p> <p>A complete-case analysis was used for this manuscript (N=8,344), resulting in a final analytic sample of 6,570 students.</p>
Quantitative variables	11	<p>Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why</p> <p><i>Binge drinking</i> (dichotomous dependent variable) was fit using binary logistic models and binge drinking frequency (ordinal dependent variable) was fit using ordinal logistic regression models. The explanatory variables were fit as dichotomous variables using the predetermined thresholds that are used to classify clinically relevant symptoms of depression and anxiety.</p>
Statistical methods	12	<p>(a) Describe all statistical methods, including those used to control for confounding</p> <p>To help with the interpretation of the results, we used a stepwise modeling approach: 1) the main effects of depression and anxiety were tested, 2) flourishing was added and main effects tested, and 3) inclusion of 2-way and 3-way interactions among depression, anxiety, and flourishing to test for moderation/significant interactions.</p> <p>(b) Describe any methods used to examine subgroups and interactions</p> <p>Using a stepwise modeling approach, we were able to evaluate any significant changes and interactions (if any) after including each variable.</p> <p>(c) Explain how missing data were addressed</p> <p>We used a complete case analysis.</p> <p>(d) If applicable, describe analytical methods taking account of sampling strategy</p> <p>N/A</p> <p>(e) Describe any sensitivity analyses</p> <p>In addition to the 2 logistic models reported on, depression and anxiety variables were separately fit as continuous variables in these models to confirm our results, however are not presented in this manuscript.</p>
Results		
Participants	13*	<p>(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed</p> <p>A complete-case analysis was used for this manuscript (N=8,344), resulting in a final analytic sample of 6,570 students.</p> <p>(b) Give reasons for non-participation at each stage</p> <p>Given the cross-sectional nature of this study, there was only one round of data collections (N=6,570). Missing data results from incomplete student surveys.</p> <p>(c) Consider use of a flow diagram</p>

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N/A

Descriptive data 14* (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders

The majority of students reported their ethnicity as white (71.4%) and 51.6% were female. Overall, 37.0% of the sample reported binge drinking at least once within the past year and 20% indicated binge drinking at least once a month. Mental health problems were common within the study sample: 41.4% of students reported clinically relevant symptoms (scores ≥ 10) for depression and 31.7% reported symptoms of anxiety (scores ≥ 10). The mean flourishing score was 16.66 (SD:5.87). Additionally, females were more apt to report depression, anxiety, and lower flourishing levels compared to males. Females were also more likely to be sporadic and monthly binge drinkers and less likely to binge drink weekly compared to males.

(b) Indicate number of participants with missing data for each variable of interest

N/A

Outcome data 15* Report numbers of outcome events or summary measures

Current binge drinkers were more likely to be in grade 10 [OR 1.56, $p < 0.001$], grade 11 [OR 1.69, $p < 0.001$], and grade 12 [OR 2.31, $p < 0.001$]. The same demographic trends were observed for binge drinking frequency, whereby students in older grades were more likely to report higher binge drinking frequencies and the odds of this increased for every grade level. Cannabis use [OR 7.76, $p < 0.001$], tobacco smoking [OR 3.00, $p < 0.001$], truancy [OR 2.29, $p < 0.001$] and being involved on a sports team [OR 1.67, $p < 0.001$] were significantly associated with an increased odds of binge drinking. Similarly cannabis use [OR 7.12, $p < 0.001$], tobacco smoking [OR 3.94, $p < 0.001$], truancy [OR 2.04, $p < 0.001$] and being involved on a sports team [OR 1.64, $p < 0.001$] were associated with increases in binge drinking frequency. Compared to those who reported not having any spending money, youth with \$1-\$20 of weekly spending money were 1.37 times more likely to binge drink and the odds of binge drinking doubled (2.68) for youth with greater than \$100 of weekly spending money.

Main results 16 (a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included

Sub-clinical symptoms of depression and anxiety and self-reported flourishing were not found to be significantly associated with binge drinking or binge drinking frequency within our sample. Moreover, the addition of interaction terms did not lead to any changes in estimations or significance; therefore, flourishing did not moderate the association between mental health problems and binge drinking behaviours as hypothesized and was not found to be a confounding variable as seen in recent cannabis research.

(b) Report category boundaries when continuous variables were categorized

Consistent with other research, this study applied a binary coding system to categorize students with and without clinically relevant symptoms (control=0, depression and/or anxiety=1) using scores ≥ 10 for both depression and anxiety to indicate the presence of mental health problems.

(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period

N/A

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
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N/A

Discussion

Key results	18	Summarise key results with reference to study objectives
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Our results correspond with previous surveillance research and national averages showing alcohol is the most prevalent substance used among Canadian adolescents and identified that almost one third of youth in Ontario and British Columbia, who participated in the COMPASS MH-M pilot study, reported binge drinking within the past 12 months, and almost 1 in 6 students reported this behaviour monthly. Depression and anxiety were also found to be highly prevalent mental health problems among our large sample of youth; nearly one-half of students indicated symptoms of clinically relevant depression and one third reported clinically relevant symptoms of anxiety. Although highly prevalent, depression and anxiety were not associated with binge drinking, and flourishing was not found to be a moderating factor. While recent cannabis research suggest that mental health and wellbeing are associated with youth cannabis use, this research indicates that it is unlikely youth use alcohol for the same reasons as cannabis suggesting substance-specific interventions to be developed.

Our findings provide support for the association between binge drinking patterns and the behavioural influences outlined by Theory of Planned Behaviour, as demonstrated elsewhere. Distal factors of this theory such as socioeconomic status, were also found to be associated with binge drinking among our sample of youth. We identified a strong dose-response relationship between binge drinking and weekly spending money, indicating that socioeconomic status may be correlated with alcohol consumption among youth, whereby greater amounts of weekly spending money was associated with an increased likelihood of binge drinking and binge drinking frequency.

Existing literature indicates the perception of peer alcohol use may be the strongest predictor of adolescent drinking behaviour.(18) Underlying motives for alcohol consumption may represent important insight for intervention strategies given that alcohol consumption is situational and may differ across

individuals. This may provide reason for our lack of association found between mental health problems and binge drinking, and suggests that alcohol consumption may result due to social interaction and establishing relationships with peers. Given the differences in significant predictors for alcohol and cannabis among the same sample of COMPASS participants, it is necessary to consider tailored approaches for each individual substance, rather than developing intervention programs that address the use of many substances simultaneously.

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13 14 15 16 17 18 19 20 21 22 23 24 25 26 27	Limitations	19	<p>Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias</p> <p>Since student data are self-reported, findings may be subject to reporting or recall bias, however, passive permission protocols have been implemented to preserve anonymity. Mental health items were measured using scales and were based on 1-2 week recall; as such, these measures are not diagnostic and cannot determine whether symptoms were chronic or short term. Lastly, this study was unable to examine broader social environments that may be associated with alcohol consumption patterns, and was unable to establish binge drinking trajectories in relation to mental health problems given the cross-sectional nature of the data.</p>
28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47	Interpretation	20	<p>Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence</p> <p>A large proportion of the study sample of grade 9-12 students reports binge drinking. While symptoms of depression and anxiety are also highly prevalent in this population, our research shows that they are likely not responsible for explaining patterns of excessive alcohol consumption in our youth sample. Contrary to our hypothesis, flourishing was not shown to moderate the relationship between mental health and binge drinking in high school students. This new analysis of the COMPASS mental health data and alcohol use among youth suggests that binge drinking among youth may be a product of social acceptability and normalcy. Future interventions may consider peer-to-peer mentoring and research should aim to consider the role of social environments and alcohol consumption, and where data is available, targeting binge drinking within a team dynamic and among different types of sports.</p>
48 49 50 51 52 53 54	Generalisability	21	<p>Discuss the generalisability (external validity) of the study results</p> <p>The COMPASS Study was not designed to collect representative data as sampling was purposeful and we used an active-information, passive consent protocol.</p>
55	Other information		
56 57 58 59 60	Funding	22	<p>Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based</p> <p>The COMPASS Study, including the Mental Health Module, is supported by funds from the Canadian Institutes of Health Research (CIHR) (PJT-149092;</p>

grant awarded to Patte and Leatherdale). The COMPASS study extension (2016-2021) was supported by a CIHR Project Grant (PJT-148562; grant awarded to Leatherdale). The COMPASS expansion to additional jurisdictions was funded by a Health Canada grant through the Substance Use and Addictions Program (SUAP). The creation of this manuscript was funded by the Research Affiliate Program from the Public Health Agency of Canada, Applied Research Branch

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Psychological correlates and binge drinking behaviours among Canadian youth: a cross-sectional analysis of the mental health pilot data from the COMPASS Study

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Manuscripts

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3 **Psychological correlates and binge drinking behaviours among Canadian youth: a cross-sectional**
4 **analysis of the mental health pilot data from the COMPASS Study**
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ABSTRACT

Objective: The objective of this study was to examine associations between depression, anxiety, and binge drinking among a large sample of Canadian youth, while testing the moderating effect of flourishing. This research uses data from the COMPASS study (2012-2021) with a large sample size collecting data on youth health behaviours within Canadian secondary schools.

Design: Cross-sectional

Setting: 14 secondary schools across Ontario and British Columbia, Canada.

Participants: A sample of grade 9-12 students (n=6570) who participated in the Mental Health pilot of the COMPASS study

Primary and secondary outcome measures: Self-reported questionnaires assessed student binge drinking behaviours (5 ≥ drinks), symptoms of depression (CESD-R-10 scores ≥ 10) and anxiety (GAD-7 scores ≥ 10), and flourishing (Diener's Flourishing Scale: 8-40).

Results: In our sample of 6,570 students, 37.0% of students reported binge drinking in the last year, and 41.4% and 31.7% of students report clinically-relevant symptoms of depression and anxiety, respectively. Anxiety (AOR: 0.57, 99% CI [0.15-2.22]) and depression (AOR: 1.98, 99% CI [0.76-5.13]) symptoms were not found to be associated with binge drinking and we did not detect any moderating role of flourishing. Rather, factors that were associated with increased odds of binge drinking included sports team participation (AOR: 1.67, 99% CI [1.37-2.03]) and use of other substances [tobacco (AOR: 3.00, 99% CI [2.12-4.25]) and cannabis (AOR: 7.76, 99% CI [6.36-9.46])]. Similar associations were found for frequency of binge drinking.

Conclusions: Consistent with existing literature, binge drinking behaviours were problematic, as well as clinically-relevant symptoms of depression and anxiety. However, mental health problems and wellbeing may not be responsible for explaining patterns of binge drinking in youth. Targeted intervention efforts towards student athletes and concurrent substance users are necessary for addressing binge drinking in youth populations.

Article Summary

Strengths and Limitations

- The COMPASS project is a unique data system that provides an ideal platform to evaluate multiple co-occurring behavioural trajectories among a large sample of Canadian youth.
- Only cross-sectional results are reported as this study used first year pilot data for a mental health module to examine associations between mental health problems and binge drinking; future waves of COMPASS will allow mental health trajectories to be explored.
- Purposive sampling methods were used and results may not be representative of all Ontario and British Columbia secondary schools.
- Although findings may be subject to reporting or recall bias as data were self-reported, passive permission protocols and unique self-generated identification codes have been implemented to preserve anonymity.
- This study was unable to examine broader social environments (e.g., social acceptability of alcohol, sport team dynamics) that may be associated with alcohol consumption patterns.

Introduction

Although federal and provincial legislations in Canada prohibit alcohol consumption for those under the age of 18 or 19, about 25% of Canadian students in grade 7 to 12 report past-year binge drinking, which has been previously operationalized as consuming five or more drinks on one occasion.^(1,2) In comparison, 17% of youth report past-year cannabis use and 10% report using tobacco products in the past-30-days.⁽²⁾ Acute and chronic health risks of early-onset alcohol use can be severe, including potential neurologic and psychosocial concerns. As brain development continues throughout adolescence, youth are especially vulnerable to the effects of alcohol, particularly in high volumes and frequent doses.^(3,4) Alcohol consumption during adolescence may contribute to future experiences of psychiatric and substance use disorders ^(3,5), and youth who partake in binge drinking are at increased risk for such adverse health outcomes compared to youth who do not.^(6–9) Binge drinking ^(10,11) and frequency of drunkenness ⁽¹²⁾ during adolescence have been linked to negative psychological outcomes including conduct disorder, anxiety, depression, and suicidal behaviour.

Binge drinking has many negative physiological effects on the brain ⁽¹³⁾ and may lead to impaired mood and symptoms of depression among youth.^(14,15) Longitudinal research has found problem-use of alcohol during adolescence to be predictive of depression in young adulthood.⁽¹⁴⁾ Alternatively, depression has been found to predict subsequent alcohol use, and research suggests that youth who experience depressive symptoms may binge drink in attempt to reduce negative affect.^(16,17) Negative affect is a strong predictor of harmful drinking and may distinguish between customary or social drinking behaviours, and abusive drinking trajectories.⁽¹⁸⁾ Males and females demonstrate unique vulnerabilities to binge drinking in relation to biopsychosocial functioning.⁽¹⁹⁾ However, consequences from binge drinking may be more severe or prevalent in females considering they are at an increased risk of experiencing symptoms of mental health problems.⁽¹⁹⁾ Although adolescent males have previously been at greater risk for alcohol use and use at higher frequencies, this gender gap has gradually lessened where binge drinking among adolescent females has become more common.^(20,21) Previous studies have cited risk-taking behaviour ⁽²²⁾ including tobacco and cannabis use ⁽²³⁾, participation in team sports ^(24,25), being of white ethnicity ^(25,26) and having higher amounts of spending money ⁽²⁵⁾ as common risk factors for binge drinking among secondary school students.

Widespread alcohol use among youth may also be explained by the *Theory of Planned Behaviour*.⁽²⁷⁾ The Theory of Planned Behaviour is a psychosocial model that has been effectively applied to the prediction of many health behaviours by considering an individual's attitude, subjective norms, and perceived behavioural control.⁽²⁷⁾ Within Canada, alcohol is generally recognized as a socially acceptable and popular substance.⁽¹⁾ Research suggests normative social influences and cultural norms may also play an important role in explaining drinking patterns.^(28,29) Given this, behaviours may result from interactions with surrounding social environments and contribute to the development of positive perceptions of drinking.^(30–32) These positive perceptions can create an environment where drinking behaviour is both accepted and encouraged socially, and may contribute to increased alcohol consumption and binge drinking.^(30,33,34) Despite the potential hazardous health outcomes and biopsychosocial problems associated with binge drinking ⁽¹³⁾, it is often viewed as a positive social activity; an important aspect to consider when exploring the relationship between drinking and mental wellbeing. One study found that drinking with friends is protective against alcohol-related problems (e.g., physical fights or injuries, driving under the influence, hangovers or vomiting).⁽³⁵⁾ As such, research has suggested that social drinking may coincide with aspects of positive psychosocial wellbeing

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3 such as social participation, enhanced self-esteem and autonomy, coping strategies, and
4 accountability.(36)
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7 Flourishing is the presence of positive mental health, inclusive of emotional, psychological, and
8 social prosperity, and often used as an indicator of overall psychosocial wellbeing.(37–39) Flourishing
9 incorporates contemporary theories of wellbeing, acknowledging the importance of social relationships,
10 not just for pleasure but self-perceived interest and engagement, and meaning and purpose in life.
11 Given that flourishing represents a modernized concept in the field of psychology, limited research
12 currently existing exploring the impact positive wellbeing may have on overall substance use behaviours.
13 However, recent findings examining the association between mental health problems and cannabis use
14 demonstrated that after controlling for depression and anxiety, youth who reported flourishing were
15 found to be less likely to have used cannabis and less likely to have used at higher frequencies.(40) As
16 flourishing may offer protective effects against cannabis (40), additional research on the influence of
17 overall wellbeing within other substance use domains (e.g., alcohol and tobacco use) is necessary to
18 inform strategies for youth prevention or intervention programming.
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21 The authors are unaware of existing research that has evaluated indicators of mental wellbeing,
22 such as flourishing, as a protective factor against binge drinking and mental health problems among
23 youth. In response to this gap, the objective of the current study was to examine the association
24 between binge drinking and depression and anxiety symptoms among a large sample of Canadian youth.
25 Our analysis is intended as a follow-up to novel findings between cannabis and flourishing (40) and we
26 aim to contribute to the literature by examining whether flourishing moderates the association between
27 depression, anxiety, and binge drinking behaviour within Canadian secondary school students.
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31 **Methods**

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33 The COMPASS Study is a prospective cohort study (2012–2021) that collects data from full school
34 samples of students in grades 9 through 12 attending participating secondary schools across
35 Canada.(41) A new COMPASS mental health module (MH-M) was piloted in year 5 COMPASS data
36 collections (Y₅[2016–2017]), as students' mental health was identified by stakeholders as a priority area
37 for study.(42) This paper uses the data collected from students attending the 14 COMPASS schools that
38 were selected to participate in the MH-M pilot via the COMPASS student questionnaire.(42) The original
39 COMPASS study protocol was maintained with the exception of the eight new subsections about youth
40 mental health that were added to supplement the original student questionnaire.(41,43,44) A complete
41 description of COMPASS methods is available in print (41) or online (www.compass.uwaterloo.ca). This
42 study received ethics approval from the University of Waterloo Human Research Ethics Committee and
43 all participating school boards.
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47 Data were collected from 8,344 students attending selected secondary schools in British
48 Columbia (N=5) and Ontario (N=9), Canada. Specific schools were recruited to participate in the pilot
49 stage of the mental health module during year 5 of the COMPASS data collection based on expressed
50 interest in the mental health data. Students were recruited using a parental active-information passive-
51 consent permission protocol (41), a strategy shown to be important for collecting robust data on self-
52 reported risk behaviours such as substance use among youth.(45–47) A complete-case analysis was used
53 for this manuscript (N=8,344), resulting in a final analytic sample of 6,570 students.
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56 **Patient and public involvement**

There were no patients involved in the development of the research study. School board stakeholders were involved throughout the development of the pilot mental health module as part of the working research team. Anonymized school-, board- and province-level results were prepared for applicable stakeholders in the form of a report. See www.compass.uwaterloo.ca for protocol details.

Measures

Binge Drinking

Consistent with previous research (48), binge drinking was assessed by asking students “In the last 12 months, how often did you have 5 drinks of alcohol or more on one occasion?” Responses were recoded into a binary measure of binge drinking, where students who indicated not having done this in the past 12 months, were classified as “non-current binge drinkers” and all other responses were coded as “current binge drinkers.” For ordinal responses, binge drinking frequency was collapsed into the following: “non-current binge drinkers,” consistent with the binary variable explained above; “rare/sporadic,” if respondents indicated binge drinking less than once a month; “monthly,” if reported use was once to 3 times per month, and; “weekly,” if use ranged from once a week to daily.

Mental health variables

Youth depressive symptoms were assessed using *the Center for Epidemiologic Studies Depression Scale (Revised)-10* (CESD-R-10; (49)). This 10-item scale was designed to assess self-reported symptoms characteristic of depression such as feelings of sadness, hopelessness, apathy and motivation, irritability, and difficulties sleeping, making decisions, and concentrating over a 1-week period.(49–51) Internal consistency of the CESD-R-10 scale was high ($\alpha=0.98$). Anxiety symptoms were measured using the *Generalized Anxiety Disorder 7-item Scale* (GAD-7; (52)). The GAD-7 assesses on difficulty controlling feelings of worry, trouble relaxing, nervousness, restlessness, and irritability over a 2-week period of time and had high internal consistency ($\alpha=0.99$). Both scales have been validated for use in adolescent populations.(50–52) The CESD-R-10 and GAD-7 scales were fit as dichotomous variables for each model; consistent with other research, this study applied a binary coding system to categorize students with and without clinically-relevant symptoms (control=0, depression and/or anxiety=1) using scores ≥ 10 for both the CESD-R-10 (49,51) and GAD-7 (52) to indicate risk of or probable depression and anxiety, respectively.

Levels of self-perceived psychosocial wellbeing among students was measured using *Diener’s Flourishing Scale (FS; (53))*. This scale provides a score that represents overall psychological functioning on a flourishing-languishing continuum by assessing how students perceive their: relationships, life purpose and satisfaction, engagement with and interest in daily activities, self-esteem, competence, and optimism. To remain suitable for large, school-based studies (44), the original 7-point Likert scale was reduced to a 5-point response option with total scores ranging from 8 to 40. All item statements are positively framed within the original FS.(53) However, to remain consistent with the other COMPASS MH-M measures, the FS was reverse coded where low scores represented flourishing (good overall wellbeing) and high scores represent languishing (an indication of poor overall psychosocial wellbeing). Internal consistency of the FS was high ($\alpha= 0.98$).

Covariates

The following covariates were accounted for: grade (9, 10, 11, 12); sex (female, male); ethnicity (White, Black, Asian, Indigenous [First Nations, Métis, Inuit], Latin American or Hispanic, Mixed/Other); weekly spending money (\$0, \$1-\$20, \$21-\$100, more than \$100, I don’t know; as a proxy for socioeconomic status, as this is a more accessible value for youth to report on than household income); truancy (no skipped classes, 1 or more missed classes per week); cannabis use (never use, ever user [ever using marijuana]); smoking status (non-smoker [reported never smoking or non-current use of

cigarettes], current smoker [reported smoking one or more cigarettes in the past month]) and team sport involvement (not involved, involved [school- or community-level]).

Analysis

Among our analytic sample, descriptive analyses were conducted using χ^2 and t tests. Binge drinking status (non-current vs current binge drinker) was modelled using a binary logistic regression (model 1) and binge drinking frequency was modelled using an ordinal logistic regression (model 2) which adjusted for relevant covariates. Given the large sample size, a confidence interval of 99% was used. The frequency of binge drinking was modeled to examine if mental health problems were associated with increasing levels of binge drinking frequencies. To examine flourishing as a moderating variable, 2- and 3-way interactions between flourishing, depression and anxiety were tested. Only complete-case analysis was conducted where 11% of GAD-7 data, 18% of CESD-R-10 data and less than 1% of binge drinking was missing. The impact of data was assessed and we found no meaningful difference among students with and without missing data. All analyses were conducted in SAS 9.4.(54)

Results

Sample characteristics

Demographic characteristics for the total sample (n=6,570) are presented in Table 1. The majority of students reported their ethnicity as white (71.4%) and 51.6% were female. Overall, 37.0% of the sample reported binge drinking at least once within the past year and 20% indicated binge drinking at least once a month. Clinically-relevant symptoms (scores ≥ 10) for depression were reported by 41.4% of students in the sample and 31.7% reported symptoms of anxiety above the threshold (scores ≥ 10). The mean flourishing score was 16.66 (SD:5.87) and after examining descriptive results by sex, females (17.23 [SD:6.00]) reported greater languishing scores than males (15.99 [SD:5.65]). More females reported clinically-relevant symptoms of depression (51.9% vs 30.1%) and anxiety (43.5% vs 19.1%), compared to their male counterparts. Although the rate of binge drinking among females and males was similar, females were more likely to engage in sporadic (18.7% vs 15.3%) and monthly (15.2% vs 14.6%) binge drinking and less likely to binge drink weekly (3.9% vs 6.3%), compared to males.

Correlates of drinking behaviours

Table 2 demonstrates results of the regression models used for predicting binge drinking behaviours. Youth reporting current binge drinking were more likely to be in grade 12 [AOR 2.31, 99% CI 1.74-3.02], grade 11 [AOR 1.69, 99% CI 1.29-2.20], and grade 10 [AOR 1.56, 99% CI 1.21-2.00] in Model 1. The same demographic trends were observed in Model 2 for binge drinking frequency, whereby students in older grades were more likely to report higher binge drinking frequencies. As seen in Model 1, cannabis use [AOR: 7.76, 99% CI 6.36-9.46], tobacco smoking [AOR 3.00, 99% CI 2.12-4.25], truancy [AOR 2.29, 99% CI 1.90-2.76] and being involved with a sports team [AOR 1.67, 99% CI 1.37-2.03] were significantly associated with an increased odds of binge drinking. Similarly, cannabis use [AOR 7.12, 99% CI 5.95-8.52], tobacco smoking [AOR 3.94, 99% CI 3.11-4.99], truancy [AOR 2.04, 99% CI 1.73-2.41] and being involved on a sports team [AOR 1.64, 99% CI 1.39-1.93] were associated with increases in binge drinking frequency in Model 2. Compared to those who reported not having any spending money, youth with \$1-\$20 of weekly spending money were 1.37 times more likely to binge drink and the odds of binge drinking doubled (AOR: 2.68) for youth with greater than \$100 of weekly spending money (Model 1). Although mental health indicators were not found to be statistically significant, directionality of the adjusted odds ratios suggests a potentially positive association between depression and binge drinking [AOR: 1.98, 99% CI 0.76-5.13], as well as a negative association between anxiety and binge drinking [AOR: 0.57, 99% CI 0.15-2.22].

Moderating effects of flourishing

Above-threshold symptoms of depression and anxiety, and self-reported flourishing were not found to be significantly associated with binge drinking or binge drinking frequency within our sample. Moreover, the addition of interaction terms did not lead to any changes in estimations or significance; therefore, flourishing did not moderate the association between depression or anxiety symptoms and binge drinking behaviours as hypothesized.

Discussion

Our findings correspond with previous surveillance research and national averages showing alcohol is the most common substance used among our sample of Canadian adolescents.^(1,2) This study identified that more than one-third of youth in Ontario and British Columbia, Canada who participated in the COMPASS MH-M pilot study, reported binge drinking within the past 12 months, and almost 1 in 6 students reported this behaviour monthly. Within our large sample of youth, nearly one-half of students indicated symptoms of clinically-relevant depression and one-third reported clinically-relevant symptoms of anxiety. Consistent with other research⁽⁵⁵⁾ as well as existing findings from the COMPASS MH-M pilot study⁽⁴⁰⁾, neither depression nor anxiety were correlated with binge drinking. However, unlike previous COMPASS research that found flourishing may protect against cannabis use⁽⁴⁰⁾, these corresponding association were not observed within this study for binge drinking. Based on these findings, youth may use alcohol for different reasons than cannabis, suggesting the two substances may play distinct social and psychological roles.

As literature continues to present inconsistent findings between mental health and substance use, it is critical to acknowledge subgroups of consumers^(18,56) as underlying motives for alcohol consumption may represent important insight for intervention strategies.⁽⁵⁷⁾ In Canada, alcohol consumption exists as a normative social behaviour⁽⁵⁸⁾ that is common to many population⁽¹⁾, including youth.^(28,29,32) This custom may provide reason for the lack of associations observed in this study, and suggests that alcohol consumption may more commonly occur as a social activity rather than a coping mechanism for negative affect, attenuating potential associations between mental health problems and binge drinking. Such links between social influence and binge drinking have also been demonstrated elsewhere^(59–62) and ultimately provide support for the *Theory of Planned Behaviour*. Schlegel et al.⁽⁶²⁾ found attitudes towards binge drinking and perceived social norms all contributed to the intention and frequency of binge drinking. Moreover, binge drinking in youth has been shown to be associated with peer group influences, whereby peer alcohol use may be the strongest predictor of adolescent drinking behaviour, presenting important implications for intervention approaches.^(28,63) Distal components of this theory, such as socioeconomic status, were also found to be associated with binge drinking in our sample. We identified a strong dose-response relationship between binge drinking and weekly spending money, with greater amounts of weekly spending money predicting an increased likelihood of binge drinking and binge drinking frequency. Our results may reflect a correlation between socioeconomic status and alcohol consumption among youth, or at least appear to indicate that available spending money (e.g., provided by parental, part-time employment, or other sources) provides the means to purchase alcohol.

These findings supplement other substance use literature and identify that co-occurring substance use is common among students who binge drink.^(64–67) Youth engaging in current binge drinking were approximately three times more likely to smoke tobacco and almost eight times more likely to use cannabis. Sports team participation appeared to also be a strong predictor of binge

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3 drinking. Adding this variable improved the predictive accuracy of our logistic models, as demonstrated
4 by the concordance statistic. While sports team participation can contribute to positive health
5 behaviours among youth (e.g. physical activity), patterns of excessive alcohol consumption among
6 school athletes has been previously observed in research.(68)
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8
9 The Canadian Centre on Substance Abuse recognizes that sports participation is linked to
10 decreases in illicit drug use among youth, but the use of alcohol increases.(69) Youth between the ages
11 of 15 to 19 years have the highest participation rates in sports.(70) Athletic involvement presents an
12 optimal opportunity to influence youth by leveraging their team sport environments and implementing
13 targeted prevention strategies.(69) Substance use is commonly initiated during adolescence, where
14 enrolment in sports is high, and as such, this is a critical period for substance use prevention efforts.(71)
15 For instance, public health authorities may consider limiting or restricting alcohol promotion during
16 events that may be attended by youth. Continued research is necessary within this domain as there
17 remains a paucity of evidence on the risk of binge drinking within a team dynamic.
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20 Given the varied predictors for alcohol and cannabis use among youth in the COMPASS MH-M
21 pilot study, tailored approaches for each individual substance may be necessary. Although statistically
22 insignificant, our findings present interesting results that suggest depression and anxiety may have
23 different outcomes for alcohol consumption, and the directionality of associations observed may
24 provide insight to public health researchers. Based heavily on the Theory of Planned Behaviour, existing
25 psychosocial research suggests that persuading attitudes and norms to influence behaviour may prove
26 effective at producing long-term changes.(72) Successful strategies may involve peer-to-peer mentoring
27 or social norming campaigns given the influence peer groups have on attitudes towards alcohol
28 consumption and, in turn, binge drinking behaviour.(28,29,32) Also, targeted intervention efforts
29 implemented within the environment of a sports team dynamic may effectively influence health
30 behaviours. Research should aim to examine substance use behaviours both separately and
31 concurrently; further exploration may consider the possible association between mental health and co-
32 occurring alcohol and cannabis use. Future waves of the COMPASS Study will be able to test these
33 correlations and temporal relationships.
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36 37 *Strengths and Limitations*

38 The COMPASS Study is a unique data system that examines Canadian youth risk behaviours, and
39 provides an ideal platform to evaluate multiple co-occurring behaviours and changes over time. Our
40 results supplement existing evidence and advance knowledge on youth binge drinking behaviours.
41 Important correlates identified in this study can be used to inform the creation of effective prevention
42 and intervention programs. While this study provides a novel contribution to the literature, it is not
43 without limitations. COMPASS uses a purposeful sampling method, and results are not representative of
44 all Ontario and British Columbia youth or secondary schools. Since student data are self-reported,
45 findings may be subject to reporting or recall bias, however, passive permission protocols have been
46 implemented to improve sample representativeness and preserve anonymity. By employing a complete-
47 case analysis, associations observed within this study may be underestimated. Data appeared to missing
48 at random and information bias from non-differential misclassification is possible. Mental health items
49 were measured based on 1-2 week recall and although scales employed in this study have been widely
50 validated, these measures cannot be determine whether symptoms were chronic or acute. Moreover,
51 depression and anxiety data were measured using scales and not diagnostic criteria. This study was
52 unable to examine broader social environments (e.g., social acceptability of alcohol, sport team
53 dynamics) that may be associated with alcohol consumption patterns. Lastly, we were unable to
54 establish binge drinking trajectories in relation to depression and anxiety given the cross-sectional
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3 nature of the data. As COMPASS employs a longitudinal study design, follow-up research and
4 examination of how behaviours evolve over time is possible once future waves of mental health data
5 become available.
6

7 8 *Conclusion*

9 A large proportion of the study sample of grade 9 to 12 students reported binge drinking. About
10 one-half and one-third of students reports clinically-relevant symptoms of depression and anxiety
11 respectively, however, our research shows that mental health problems were likely not responsible for
12 explaining patterns of alcohol consumption in our youth sample. Contrary to other COMPASS research
13 on cannabis use, flourishing was not shown to moderate the relationship between depression or anxiety
14 and binge drinking in secondary school students. This new analysis of the COMPASS mental health data
15 and youth alcohol use suggests that binge drinking among youth may be a product of social acceptability
16 and normalcy, as opposed to a coping mechanism or contributor to mental health problems. Future
17 research should aim to consider the role of social environments and alcohol consumption among youth,
18 and where data is available, targeting binge drinking within a team dynamic and among different types
19 of sports.
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24 *Declarations*

25 26 **Ethics approval and consent to participate**

27 The COMPASS Study received ethics approval from the University of Waterloo Office of Research Ethics
28 as well as participating school boards (ORE #: 30118).
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31 **Consent for publication**

32 Using an active-information, passive-consent protocol, all participants gave consent for the use of their
33 anonymous data.
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36 **Data statement:**

37 A data request form to access to the COMPASS data can be found at: [https://uwaterloo.ca/compass-
38 system/information-researchers/data-usage-application](https://uwaterloo.ca/compass-system/information-researchers/data-usage-application)
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49

50 **Authors’ contributions**

51 AEB and IR conceived the manuscript idea, performed the statistical analyses, drafted the manuscript,
52 and revised the manuscript for content. IR, MAF, KAP, MG, and YJ revised the manuscript for critical
53 content. STL conceived the host study, led the acquisition of all data, drafted components of
54 introduction and discussion, and revised the manuscript for critical content. All authors that have
55 contributed significantly to the work presented within this manuscript have been listed above.
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Table 1. Sample descriptives by sex for grade 9-12 students in year 5 of the mental health pilot of COMPASS (2016-2017)

		Total N=6570	Female N=3389	Male N=3181	
		% (n) †	% (n) †	% (n) †	Chi-Square (p-value)
Grade	9	27.9 (1833)	26.9 (913)	28.9 (920)	5.18 (0.16)
	10	29.3 (1923)	30.1 (1021)	28.4 (902)	
	11	24.3 (1597)	24.0 (812)	24.7 (785)	
	12	18.5 (1217)	19.0 (643)	18.0 (574)	
Ethnicity	White	71.4 (4476)	71.3 (2314)	71.5 (2162)	29.49 (<0.0001)
	Indigenous	2.2 (135)	2.0 (66)	2.3 (69)	
	Asian	10.3 (645)	10.6 (343)	9.9 (302)	
	Black	2.5 (156)	1.9 (60)	3.2 (96)	
	Latin American	2.6 (164)	2.0 (65)	3.3 (99)	
	Other/Mixed	11.0 (694)	12.2 (396)	9.8 (298)	
Province	Ontario	57.1 (3749)	56.7 (1920)	57.5 (1829)	0.48 (0.49)
	British Columbia	42.9 (2821)	43.3 (1469)	42.5 (1352)	
Weekly spending money	\$0	15.3 (1004)	13.4 (451)	17.5 (553)	54.93 (<0.0001)
	\$1-\$20	26.8 (175)	27.4 (924)	26.2 (829)	
	\$21-\$100	25.2 (1650)	27.0 (913)	23.3 (737)	
	>\$100	20.1 (1318)	18.2 (614)	22.2 (704)	
	I don't know	12.6 (820)	14.0 (476)	10.8 (344)	
Varsity/community sport involvement	No	67.1 (4377)	71.4 (2398)	62.6 (1979)	56.92 (<0.0001)
	Yes	32.9 (2145)	28.6 (962)	37.4 (1183)	
Truancy	No skipped classes	59.8 (3898)	58.2 (1954)	61.6 (1944)	7.93 (0.005)
	1 or more	40.2 (2619)	41.8 (1406)	38.4 (1213)	
Depression	No depression	58.6 (3852)	48.1 (1629)	69.9 (2223)	321.98 (<0.0001)
	Depression (CESD-R-10 ≥ 10)	41.4 (2718)	51.9 (1760)	30.1 (958)	
Anxiety	No Anxiety	68.3 (4488)	56.5 (1915)	80.9 (2573)	450.55 (<0.0001)
	Anxiety (GAD-7 ≥ 10)	31.7 (2082)	43.5 (1474)	19.1 (608)	
Flourishing (8-40)	Mean Score (SD)	16.63 (5.87)	17.23 (6.00)	15.99 (5.65)	tValue=8.54 (<0.0001)
Smoking status	Non-smoker	89.5 (5864)	89.8 (3036)	89.2 (2828)	0.65 (0.42)
	Smoker	10.5 (688)	10.2 (345)	10.8 (343)	
Cannabis Use	Never used	67.6 (4421)	67.7 (2287)	67.5 (2134)	0.02 (0.88)
	Ever used	32.4 (2117)	32.3 (1091)	32.5 (1026)	
Binge drinking status	Non-current binge drinker	63.0 (4137)	62.2 (2109)	63.7 (2028)	1.63 (0.20)
	Binge drinker	37.0 (2433)	37.8 (1280)	36.3 (1153)	
Binge drinking frequency	Non-current binge drinker	63.0 (4137)	62.2 (2109)	63.8 (2028)	29.27 (<0.0001)
	Rare/sporadic	17.0 (1120)	18.7 (631)	15.3 (489)	
	Monthly	14.9 (980)	15.2 (516)	14.6 (464)	
	Weekly	5.1 (333)	3.9 (133)	6.3 (200)	

† Note: The numbers may not add up to the total due to missing values and rounding. Complete case analysis was conducted; 11% of GAD-7 data, 18% of CESD-R-10 data, and less than 1% of binge drinking data was missing.

Table 2. Binge drinking for grade 9-12 students in year 5 of the COMPASS MH-M (2016-2017)

		Model 1 ^a	Model 2 ^b
		AOR (99%CI) [†]	AOR (99%CI) [†]
Sex	Female	1.00	1.00
	Male	0.94 (0.78-1.14)	1.09 (0.93-1.28)
Grade	9	1.00	1.00
	10	1.56 (1.21-2.00)**	1.51 (1.20-1.89)**
	11	1.69 (1.29-2.20)**	1.62 (1.28-20.6)**
	12	2.31 (1.74-3.07)**	2.13 (1.66-2.73)**
Ethnicity	White	1.00	1.00
	Indigenous	0.84 (0.45-1.57)	0.90 (0.55-1.47)
	Asian	0.47 (0.33-0.68)*	0.53 (0.38-0.73)*
	Black	0.63 (0.35-1.13)	1.07 (0.66-1.72)
	Latin American	1.05 (0.60-1.14)	0.96 (0.59-1.56)
	Other/Mixed	0.86 (0.64-1.14)	0.92 (0.72-1.17)
Province	Ontario	1.00	1.00
	British Columbia	0.81 (0.67-0.98)*	0.86 (0.73-1.01)
Weekly spending money	\$0	1.00	1.00
	\$1-\$20	1.37 (1.00-1.87)*	1.25 (0.94-1.67)
	\$21-\$100	2.45 (1.80-3.35)**	2.12 (1.60-2.80)**
	>\$100	2.68 (1.93-3.71)**	2.34 (1.88-2.90)**
	I don't know	1.56 (1.08-2.25)*	1.50 (1.17-1.93)*
Varsity/community sport involvement	No	1.00	1.00
	Yes	1.67 (1.37-2.03)**	1.64 (1.39-1.93)**
Truancy	No skipped classes	1.00	1.00
	1 or more	2.29 (1.90-2.76)**	2.04 (1.73-2.41)**
Smoking status	Non-smoker	1.00	1.00
	Smoker	3.00 (2.12-4.25)**	3.94 (3.11-4.99)**
Cannabis Use	Never used	1.00	1.00
	Ever used	7.76 (6.36-9.46)**	7.12 (5.95-8.52)**
Mental health factors			
Depression	No Depression	1.00	1.00
	Depression (CESD-R-10 ≥10)	1.98 (0.76-5.13)	2.08 (0.92-4.69)
Anxiety	No Anxiety	1.00	1.00
	Anxiety (GAD-7 ≥10)	0.57 (0.15-2.22)	0.66 (0.20-2.16)
Flourishing	Flourishing Scale (continuous)	0.98 (0.95-1.01)	0.98 (0.96-1.00)
Interactions			
Depression*Anxiety		0.49 (0.09-2.78)	0.43 (0.10-1.91)
Depression*Flourishing		0.98 (0.92-1.03)	0.97 (0.92-1.01)
Anxiety*Flourishing		1.05 (0.96-1.14)	1.04 (0.97-1.13)
Depression*Anxiety*Flourishing		1.02 (0.92-1.13)	1.03 (0.94-1.12)
Concordance statistic		0.862	0.836
[†] Note: Complete case analysis was conducted and 2395 observations were deleted due to missing data for the mental health and binger drinking variables. ^a Note: Model 1 is a logistic regression of mental health predictors and binge drinking status ^b Note: Model 2 is an ordinal logistic regression of mental health predictors and binge drinking frequency			

* p≤0.01, **p<0.001

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Title and abstract	Item No	Recommendation
	1	(a) Indicate the study's design with a commonly used term in the title or the abstract
		Psychological correlates and binge drinking behaviours among Canadian youth: a cross-sectional analysis of the mental health pilot data from the COMPASS Study
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found
		Objective: The objective of this study was to examine the psychosocial correlates of binge drinking among a large sample of Canadian youth, while testing the moderating effect of flourishing on the potential relationship between binge drinking and clinically-relevant symptoms of mental health problems.
		Design: cross-sectional
		Setting: 14 secondary schools across Ontario and British Columbia Canada
		Participants: A sample of grade 9-12 students (n=6570) who participated in the Mental Health pilot of the COMPASS study
		Primary and secondary outcome measures: self-reported questionnaires were completed by students measuring binge drinking and its frequency associated with depression and anxiety symptoms.
		Results: In our sample of 6,570 students, 37.0% of students report binge drink in the last year, and 41.4% of students report clinically relevant symptoms of depression and 31.7% for anxiety. Anxiety (OR: 0.57 [0.15-2.22]) and depression (OR: 1.98 [0.76-5.13]) symptoms were not found to be associated with binge drinking and we did not detect any moderating role of flourishing. Rather, factors that were associated with increased odds of binge drinking included sports team participation (OR: 1.67 [1.37-2.03]) and use of other substances (tobacco (OR: 3.00 [2.12-4.25]) and cannabis (OR: 7.76 [6.36-9.46])). Similar associations were found for frequency of binge drinking.
		Conclusions: Consistent with existing literature, binge drinking behaviours were common, as were sub-clinical symptoms of depression and anxiety. However, mental health problems and wellbeing may not be responsible for explaining patterns of binge drinking in youth. Instead, our findings suggest that alcohol use among youth may be a product of social acceptability and normalcy. Targeted intervention efforts towards student athletes and concurrent substance users are necessary for addressing binge drinking in youth populations.
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
		Developing a robust understanding of the associations between youth binge drinking and mental health would be valuable in helping to inform how

different substances may be correlated with mental health and wellbeing. Binge drinking during adolescence has been linked to negative psychological outcomes including conduct disorder, anxiety, depression, and suicidal behaviour. Depression in youth has been suggested to lead to binge drinking in attempt to reduce negative emotions. Moreover, binge drinking has many negative physiological effects on the brain and may lead to impaired mood and feelings of depression, particularly in children. Given the paucity of available literature on the effects of flourishing, additional research on the influence of overall wellbeing within other substance use domains, such as adolescent binge drinking, is warranted

Objectives	3	State specific objectives, including any prespecified hypotheses
		The objective of this study was to assess the relationship between binge drinking and mental health problems including depression and anxiety among a large sample of Canadian youth. Additionally, we aim to contribute to the literature by examining whether flourishing will moderate the association between mental health problems and binge drinking behaviour within Canadian high school students.
Methods		
Study design	4	Present key elements of study design early in the paper
		The COMPASS Study (COMPASS) is a longitudinal, prospective cohort study (2012-2021) that collects data from students in grades 9 to 12 attending participating secondary schools across Canada. During the COMPASS year 5 (Y ₅ [2016-2017]) data collection, a new module was included to measure student mental health, given that schools participating in the earlier waves of COMPASS identified this as a priority area that was missing from the survey tools. As such, this paper uses the new student-level data collected from students attending 14 COMPASS schools who participated in the MH-M pilot to evaluate the how mental health problems are associated with youth binge drinking.
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
		Data were collected from 8,344 students attending selected secondary schools in British Columbia (N=5) and Ontario (N=9), Canada.
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants
		Students were recruited using a parental active-information passive-consent permission protocol. A complete-case analysis was used for this manuscript (N=8,344), resulting in a final analytic sample of 6,570 students.
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
		Our outcome variable of interest was cannabis ever use (binary) and frequency of use (ordinal [6 categories]). Exposure variables included

measures of clinically relevant symptoms of depression and anxiety and were coded as binary measures based on previously determined thresholds. Flourishing was included as a potential moderator.

Data sources/
measurement

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For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group

Binge Drinking

Binge drinking was assessed by asking students "In the last 12 months, how often did you have 5 drinks of alcohol or more on one occasion?" Responses were recoded into a binary measure of binge drinking, where students who indicated never having done this, were classified as "non-current binge drinkers" and all other responses were coded as "current binge drinkers." For ordinal responses, binge drinking frequency was collapsed into the following: "non-current binge drinkers," consistent with the binary variable explained above; "rare/sporadic," if respondents indicated binge drinking less than once a month; "monthly," if reported use was once to 3 times per month, and; "weekly," if use ranged from once a week to daily.

Mental health variables

Youth depressive symptoms were assessed using *the Center for Epidemiologic Studies Depression Scale (Revised)-10 (CESD-R10)*. This 10-item scale was designed to assess self-reported symptoms associated with depression such as feelings of sadness, loss of interest, difficulties sleeping, making decisions, and concentrating over a 1-week period. Anxiety symptoms were measured using the *Generalized Anxiety Disorder 7-item Scale (GAD-7)*. The GAD-7 reports on self-perceived feelings of worry, fear, and irritability over a 2-week period of time. Both scales have been validated for use in adolescent populations. The CESD-R-10 and GAD-7 scales were fit as dichotomous variables for each model; consistent with other research, this study applied a binary coding system to categorize students with and without clinically relevant symptoms (control=0, depression and/or anxiety=1) using scores ≥ 10 for both depression and anxiety to indicate the presence of mental health problems.

Levels of psychosocial prosperity and wellbeing among students was measured using *the Flourishing Scale (FS)*. This scale provides a score that represents overall psychological wellbeing on a flourishing-languishing continuum by assessing how students perceive their: relationships; life purpose and satisfaction; engagement with and interest in daily activities; self-esteem; competence, and; optimism. To remain suitable for large, school-based studies, the original 7-point Likert scale was reduced to a 5-point response option with total scores ranging from 8 to 40. All item statements are positively framed within the original FS.

Bias

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Describe any efforts to address potential sources of bias

Given the nature of self-reported data, the COMPASS study ensures confidentiality of data through automated student surveys and utilizes a passive consent protocol to reduce the effects of information bias (social

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desirability and recall bias) and missing data.

Study size	10	<p>Explain how the study size was arrived at</p> <p>A complete-case analysis was used for this manuscript (N=8,344), resulting in a final analytic sample of 6,570 students.</p>
Quantitative variables	11	<p>Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why</p> <p><i>Binge drinking</i> (dichotomous dependent variable) was fit using binary logistic models and binge drinking frequency (ordinal dependent variable) was fit using ordinal logistic regression models. The explanatory variables were fit as dichotomous variables using the predetermined thresholds that are used to classify clinically relevant symptoms of depression and anxiety.</p>
Statistical methods	12	<p>(a) Describe all statistical methods, including those used to control for confounding</p> <p>To help with the interpretation of the results, we used a stepwise modeling approach: 1) the main effects of depression and anxiety were tested, 2) flourishing was added and main effects tested, and 3) inclusion of 2-way and 3-way interactions among depression, anxiety, and flourishing to test for moderation/significant interactions.</p> <p>(b) Describe any methods used to examine subgroups and interactions</p> <p>Using a stepwise modeling approach, we were able to evaluate any significant changes and interactions (if any) after including each variable.</p> <p>(c) Explain how missing data were addressed</p> <p>We used a complete case analysis.</p> <p>(d) If applicable, describe analytical methods taking account of sampling strategy</p> <p>N/A</p> <p>(e) Describe any sensitivity analyses</p> <p>In addition to the 2 logistic models reported on, depression and anxiety variables were separately fit as continuous variables in these models to confirm our results, however are not presented in this manuscript.</p>
Results		
Participants	13*	<p>(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed</p> <p>A complete-case analysis was used for this manuscript (N=8,344), resulting in a final analytic sample of 6,570 students.</p> <p>(b) Give reasons for non-participation at each stage</p> <p>Given the cross-sectional nature of this study, there was only one round of data collections (N=6,570). Missing data results from incomplete student surveys.</p> <p>(c) Consider use of a flow diagram</p>

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Descriptive data	14*	<p>(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders</p> <p>The majority of students reported their ethnicity as white (71.4%) and 51.6% were female. Overall, 37.0% of the sample reported binge drinking at least once within the past year and 20% indicated binge drinking at least once a month. Mental health problems were common within the study sample: 41.4% of students reported clinically relevant symptoms (scores ≥ 10) for depression and 31.7% reported symptoms of anxiety (scores ≥ 10). The mean flourishing score was 16.66 (SD:5.87). Additionally, females were more apt to report depression, anxiety, and lower flourishing levels compared to males. Females were also more likely to be sporadic and monthly binge drinkers and less likely to binge drink weekly compared to males.</p> <p>(b) Indicate number of participants with missing data for each variable of interest</p>
		N/A
Outcome data	15*	<p>Report numbers of outcome events or summary measures</p> <p>Current binge drinkers were more likely to be in grade 10 [OR 1.56, $p < 0.001$], grade 11 [OR 1.69, $p < 0.001$], and grade 12 [OR 2.31, $p < 0.001$]. The same demographic trends were observed for binge drinking frequency, whereby students in older grades were more likely to report higher binge drinking frequencies and the odds of this increased for every grade level. Cannabis use [OR 7.76, $p < 0.001$], tobacco smoking [OR 3.00, $p < 0.001$], truancy [OR 2.29, $p < 0.001$] and being involved on a sports team [OR 1.67, $p < 0.001$] were significantly associated with an increased odds of binge drinking. Similarly cannabis use [OR 7.12, $p < 0.001$], tobacco smoking [OR 3.94, $p < 0.001$], truancy [OR 2.04, $p < 0.001$] and being involved on a sports team [OR 1.64, $p < 0.001$] were associated with increases in binge drinking frequency. Compared to those who reported not having any spending money, youth with \$1-\$20 of weekly spending money were 1.37 times more likely to binge drink and the odds of binge drinking doubled (2.68) for youth with greater than \$100 of weekly spending money.</p>
Main results	16	<p>(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included</p> <p>Sub-clinical symptoms of depression and anxiety and self-reported flourishing were not found to be significantly associated with binge drinking or binge drinking frequency within our sample. Moreover, the addition of interaction terms did not lead to any changes in estimations or significance; therefore, flourishing did not moderate the association between mental health problems and binge drinking behaviours as hypothesized and was not found to be a confounding variable as seen in recent cannabis research.</p> <p>(b) Report category boundaries when continuous variables were categorized</p>

Consistent with other research, this study applied a binary coding system to categorize students with and without clinically relevant symptoms (control=0, depression and/or anxiety=1) using scores ≥ 10 for both depression and anxiety to indicate the presence of mental health problems.

(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period

N/A

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
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N/A

Discussion

Key results	18	Summarise key results with reference to study objectives
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Our results correspond with previous surveillance research and national averages showing alcohol is the most prevalent substance used among Canadian adolescents and identified that almost one third of youth in Ontario and British Columbia, who participated in the COMPASS MH-M pilot study, reported binge drinking within the past 12 months, and almost 1 in 6 students reported this behaviour monthly. Depression and anxiety were also found to be highly prevalent mental health problems among our large sample of youth; nearly one-half of students indicated symptoms of clinically relevant depression and one third reported clinically relevant symptoms of anxiety. Although highly prevalent, depression and anxiety were not associated with binge drinking, and flourishing was not found to be a moderating factor. While recent cannabis research suggest that mental health and wellbeing are associated with youth cannabis use, this research indicates that it is unlikely youth use alcohol for the same reasons as cannabis suggesting substance-specific interventions to be developed.

Our findings provide support for the association between binge drinking patterns and the behavioural influences outlined by Theory of Planned Behaviour, as demonstrated elsewhere. Distal factors of this theory such as socioeconomic status, were also found to be associated with binge drinking among our sample of youth. We identified a strong dose-response relationship between binge drinking and weekly spending money, indicating that socioeconomic status may be correlated with alcohol consumption among youth, whereby greater amounts of weekly spending money was associated with an increased likelihood of binge drinking and binge drinking frequency.

Existing literature indicates the perception of peer alcohol use may be the strongest predictor of adolescent drinking behaviour.⁽¹⁸⁾ Underlying motives for alcohol consumption may represent important insight for intervention strategies given that alcohol consumption is situational and may differ across

individuals. This may provide reason for our lack of association found between mental health problems and binge drinking, and suggests that alcohol consumption may result due to social interaction and establishing relationships with peers. Given the differences in significant predictors for alcohol and cannabis among the same sample of COMPASS participants, it is necessary to consider tailored approaches for each individual substance, rather than developing intervention programs that address the use of many substances simultaneously.

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13	Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
14 15 16 17 18 19 20 21 22 23 24 25 26 27			Since student data are self-reported, findings may be subject to reporting or recall bias, however, passive permission protocols have been implemented to preserve anonymity. Mental health items were measured using scales and were based on 1-2 week recall; as such, these measures are not diagnostic and cannot determine whether symptoms were chronic or short term. Lastly, this study was unable to examine broader social environments that may be associated with alcohol consumption patterns, and was unable to establish binge drinking trajectories in relation to mental health problems given the cross-sectional nature of the data.
28	Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47			A large proportion of the study sample of grade 9-12 students reports binge drinking. While symptoms of depression and anxiety are also highly prevalent in this population, our research shows that they are likely not responsible for explaining patterns of excessive alcohol consumption in our youth sample. Contrary to our hypothesis, flourishing was not shown to moderate the relationship between mental health and binge drinking in high school students. This new analysis of the COMPASS mental health data and alcohol use among youth suggests that binge drinking among youth may be a product of social acceptability and normalcy. Future interventions may consider peer-to-peer mentoring and research should aim to consider the role of social environments and alcohol consumption, and where data is available, targeting binge drinking within a team dynamic and among different types of sports.
48	Generalisability	21	Discuss the generalisability (external validity) of the study results
49 50 51 52 53 54			The COMPASS Study was not designed to collect representative data as sampling was purposeful and we used an active-information, passive consent protocol.
55	Other information		
56	Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based
57 58 59 60			The COMPASS Study, including the Mental Health Module, is supported by funds from the Canadian Institutes of Health Research (CIHR) (PJT-149092;

grant awarded to Patte and Leatherdale). The COMPASS study extension (2016-2021) was supported by a CIHR Project Grant (PJT-148562; grant awarded to Leatherdale). The COMPASS expansion to additional jurisdictions was funded by a Health Canada grant through the Substance Use and Addictions Program (SUAP). The creation of this manuscript was funded by the Research Affiliate Program from the Public Health Agency of Canada, Applied Research Branch

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.