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

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2018-028558
Article Type:	Research
Date Submitted by the Author:	13-Dec-2018
Complete List of Authors:	Butler, Alexandra; University of Waterloo, School of Public Health and Health Systems Romano, Isabella; University of Waterloo, School of Public Health and Health Systems Patte, Karen; Brock University Department of Health Sciences, Ferro, Mark; University of Waterloo, School of Public Health and Health Systems de Groh, Margaret; Public Health Agency of Canada, Applied Research Division Jiang, Ying; Public Health Agency of Canada, Applied Research Division Leatherdale, Scott T.; University of Waterloo, School of Public Health and Health Systems
Keywords:	MENTAL HEALTH, Depression & mood disorders < PSYCHIATRY, Substance misuse < PSYCHIATRY, High School, Child & adolescent psychiatry < PSYCHIATRY

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

Alexandra Butler, MSc[1], Isabella Romano, BSc[1], Karen Patte, PhD[2], Mark A. Ferro, PhD[1], Margaret de Groh, PhD[3], Ying Jiang, MSc, MD[3], Scott T. Leatherdale, PhD[1]

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

2 Department of Health Sciences, Brock University, St. Catharines, ON

3 Applied Research Division, Health Promotion and Chronic Disease Prevention Branch, Public Health Agency of Canada, Ottawa, ON K1A 0K9

Corresponding author:
Alexandra Butler
University of Waterloo
200 University Avenue West
Lyle Hallman South, Room 1618H
Waterloo, Ontario, Canada
N2L 3G1
E-mail: alle.butler@uwaterloo.ca

Conflict of interest: None.

Word count: 3197

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 metal 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

The COMPASS Study is a longitudinal, prospective cohort study (2012-2021) that collects data from students in grades 9 to 12 attending participating secondary schools across Canada.(28) A new mental health module (MH-M) measuring student mental health was piloted in year 5 COMPASS data collections (Y_5[2016-2017]), as this was identified by stakeholders as a priority area for student health.(29) 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.(29) 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.(28,30,31) A complete description of COMPASS methods is available in print (28) 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 interests in the mental health data. Students were recruited using a parental active-information passive-consent permission protocol (28), a strategy shown to be important for collecting robust data on self-reported risk behaviours such as substance use among youth.(32–34) A complete-case analysis was used for this manuscript (N=8,344), resulting in a final analytic sample of 6,570 students.

Measures

Binge Drinking

Consistent with previous research (4), 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*; (35)). 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.(35–37) Internal consistency of the CESD-R-10 scale was high (α=0.98). Anxiety symptoms were measured using the *Generalized Anxiety Disorder 7-item Scale (GAD-7;* (38)). The GAD-7 reports on self-perceived feelings of worry, fear, and irritability over a 2-week period of time and had high internal consistency (α=0.99). Both scales have been validated for use in adolescent populations.(36–38) 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 (37) and anxiety (38) to indicate the presence of mental health problems.

Levels of psychosocial prosperity and wellbeing among students was measured using *the Flourishing Scale (FS;* (39)). 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 (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 (α= 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 $\chi 2$ 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 brink 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

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

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. Based heavily on the Theory of Planned Behaviour, psychosocial research suggests that persuading attitudes and norms to influence behaviour may be more effective at producing long-term changes.(61) Successful strategies may involve peer-to-peer mentoring or social norming campaigns given the influence peer groups may have on attitudes towards alcohol consumption and, in turn, binge drinking behaviour.(18–20) As well, targeted intervention efforts may be effective if implemented within the environment of a sports team dynamic to influence health behaviours. Research should aim to examine substance use behaviours both separately and concurrently, and future exploration may consider the possible association between mental health and wellbeing, and co-occurring alcohol and cannabis use; such correlations and temporal relationships can be tested using future waves of COMPASS.

Conclusion

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.

Declarations

Ethics approval and consent to participate

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

Consent for publication

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

Data statement:

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

Acknowledgements and funding

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). Dr. Ferro is the Canada Research Chair in Youth Mental Health and Dr. Scott Leatherdale is the CIHR-PHAC Chair in Applied Public Health Research. The creation of this manuscript was funded by the Research Affiliate Program from the Public Health Agency of Canada, Applied Research Branch.

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.

References

1. Office of Research and Surveillance. Canadian Tobacco Alcohol and Drugs (CTADS): 2013 summary [Internet]. CTADS 2013. 2015. Available from: https://www.canada.ca/en/health-canada/services/canadian-tobacco-alcohol-drugs-survey/2013-summary.html
2. Herciu AC, Cole A, Laxer RE, Leatherdale ST. A Cross-sectional Study Examining Factors Associated with Youth Binge Drinking in the COMPASS Study: Year 1 Data. J Alcohol Drug Depend. 2014;
3. Patrick ME, Terry-McElrath YM, Kloska DD, Schulenberg JE. High-Intensity Drinking Among Young Adults in the United States: Prevalence, Frequency, and Developmental Change. Alcohol Clin Exp Res. 2016;
4. Elton-Marshall T, Leatherdale ST, Manske SR, Wong K, Ahmed R, Burkhalter R. Research methods of the youth smoking survey (YSS). Chronic Dis Inj Can. 2011;
5. Welch KA, Carson A, Lawrie SM. Brain structure in adolescents and young adults with alcohol problems: Systematic review of imaging studies. Alcohol and Alcoholism. 2013.
6. Squeglia LM, Tapert SF, Sullivan E V., Jacobus J, Meloy MJ, Rohlfing T, et al. Brain development in heavy-drinking adolescents. Am J Psychiatry. 2015;
7. Hanson KL, Medina KL, Padula CB, Tapert SF, Brown S a. Impact of Adolescent Alcohol and Drug Use on Neuropsychological Functioning in Young Adulthood: 10-Year Outcomes. J Child Adolesc Subst Abuse. 2011;
8. Lo CC, Weber J, Cheng TC. A spatial analysis of student binge drinking, alcohol-outlet density, and social disadvantages. Am J Addict. 2013;
9. Larsen K, To T, Irving HM, Boak A, Hamilton HA, Mann RE, et al. Smoking and binge-drinking among adolescents, Ontario, Canada: Does the school neighbourhood matter? Heal Place. 2017;
10. Miller JW, Naimi TS, Brewer RD, Jones SE. Binge Drinking and Associated Health Risk Behaviors Among High School Students. Pediatrics. 2007;
11. Marmorstein NR, Iacono WG, Malone SM. Longitudinal associations between depression and substance dependence from adolescence through early adulthood. Drug Alcohol Depend. 2010;
12. Mason WA, Kosterman R, Haggerty KP, Hawkins JD, Redmond C, Spoth RL, et al. Dimensions of Adolescent Alcohol Involvement as Predictors of Young-Adult Major Depression. J Stud Alcohol Drugs. 2008;
13. Hoel S, Eriksen BM, Breidablik H-J, Meland E. Adolescent alcohol use, psychological health, and social integration. Scand J Public Health. 2004;
14. Lamis DA, Malone PS, Langhinrichsen-Rohling J, Ellis TE. Body investment, depression, and alcohol use as risk factors for suicide proneness in college students. Crisis. 2010;
15. Lansford JE, Erath S, Yu T, Pettit GS, Dodge KA, Bates JE. The developmental course of illicit substance use from age 12 to 22: Links with depressive, anxiety, and behavior disorders at age 18. J Child Psychol Psychiatry Allied Discip. 2008;
16. Weitzman ER. Poor Mental Health, Depression, and Associations with Alcohol Consumption, Harm, and Abuse in a National Sample of Young Adults in College. J Nerv Ment Dis. 2004;
17. Archie S, Zangeneh Kazemi A, Akhtar-Danesh N. Concurrent binge drinking and depression among Canadian youth: Prevalence, patterns, and suicidality. Alcohol. 2012;
18. Brooks-Russell A, Simons-Morton B, Haynie D, Farhat T, Wang J. Longitudinal Relationship Between Drinking with Peers, Descriptive Norms, and Adolescent Alcohol Use. Prev Sci. 2014;
19. Jun M, Agley J, Huang C, Gassman RA. College Binge Drinking and Social Norms: Advancing Understanding Through Statistical Applications. J Child Adolesc Subst Abus. 2016;
20. Ali MM, Amialchuk A, Nikaj S. Alcohol consumption and social network ties among adolescents: Evidence from Add Health. Addict Behav. 2014;
21. Tanski SE, McClure AC, Li Z, Jackson K, Morgenstern M, Li Z, et al. Cued recall of alcohol

advertising on television and underage drinking behavior. JAMA Pediatr. 2015;
22. Hastings G, Anderson S, Cooke E, Gordon R. Alcohol marketing and young people's drinking: A review of the research. Journal of Public Health Policy. 2005.
23. Smith LA, Foxcroft DR. The effect of alcohol advertising, marketing and portrayal on drinking behaviour in young people: Systematic review of prospective cohort studies. BMC Public Health. 2009;
24. Gordon R, Mackintosh AM, Moodie C. The impact of alcohol marketing on youth drinking behaviour: A two-stage cohort study. Alcohol Alcohol. 2010;
25. Clapp JD, Shillington AM, Segars LB. Deconstructing contexts of binge drinking among college students. Am J Drug Alcohol Abuse. 2000;
26. Nyqvist F, Pape B, Pellfolk T, Forsman AK, Wahlbeck K. Structural and Cognitive Aspects of Social Capital and All-Cause Mortality: A Meta-Analysis of Cohort Studies. Soc Indic Res. 2014;
27. Butler A. Exploring the association between cannabis use, depression, anxiety and flourishing in youth: a cross-sectional analysis from year 5 of the COMPASS Mental Health pilot data. University of Waterloo; 2018.
28. Leatherdale ST, Brown KS, Carson V, Childs RA, Dubin JA, Elliott SJ, et al. The COMPASS study: A longitudinal hierarchical research platform for evaluating natural experiments related to changes in school-level programs, policies and built environment resources. BMC Public Health. 2014;
29. Patte KA, Henderson J, Faulkner G, Elton-Marshall, Sabiston C, Bredin C, Battista K LS. Development of a mental health module for the COMPASS system: Improving youth mental health trajectories. [Internet]. Waterloo; 2017. Available from: www.compass.uwaterloo.ca
30. Patte KA, Bredin C, Henderson J, Elton-Marshall T, Faulkner G, Sabiston C, Battista K, Ferro M, Cole A, Doggett A, Godin K, Aleyan S, Butler A L ST. Development of a mental health module for the COMPASS system: Improving youth mental health trajectories. Part 2: Pilot test and focus group results. [Internet]. 2017. Available from: www.compass.uwaterloo.ca.
31. Patte KA, Bredin C, Henderson J, Elton-Marshall T, Faulkner G, Sabiston C, Battista K L ST. Development of a mental health module for the COMPASS system: Improving youth mental health trajectories. Part 1: Draft Development and Design [Internet]. 2017. Available from: www.compass.uwaterloo.ca.
32. Flicker S, Guta A. Ethical Approaches to Adolescent Participation in Sexual Health Research. J Adolesc Heal. 2008;
33. White VM, Hill DJ, Effendi Y. How does active parental consent influence the findings of drug-use surveys in schools? Eval Rev. 2004;
34. Hollmann CM, Mcnamara JR. Considerations in the use of active and passive parental consent procedures. J Psychol Interdiscip Appl. 2010;
35. Andresen EM, Malmgren J a, Carter WB, Patrick DL. Screening for depression in well older adults: evaluation of a short form of the CES-D (Center for Epidemiologic Studies Depression Scale). Am J Prev Med. 1994;
36. Zhang W, O'Brien N, Forrest JI, Salters KA, Patterson TL, Montaner JSG, et al. Validating a shortened depression scale (10 item CES-D) among HIV-Positive people in British Columbia, Canada. PLoS One. 2012;
37. Bradley KL, Bagnell AL, Brannen CL. Factorial validity of the center for epidemiological studies depression 10 in adolescents. Issues Ment Health Nurs. 2010;
38. Spitzer RL, Kroenke K, Williams JBW, Löwe B. A Brief Measure for Assessing Generalized Anxiety Disorder. Arch Intern Med. 2006;
39. Diener E, Wirtz D, Tov W, Kim-Prieto C, Choi D won, Oishi S, et al. New well-being measures: Short scales to assess flourishing and positive and negative feelings. Soc Indic Res. 2010;
40. Leatherdale ST. An examination of the co-occurrence of modifiable risk factors associated with

chronic disease among youth in the COMPASS study. Cancer Causes Control. 2015;
41. O'Hara RE, Cooper ML. Bidirectional Associations Between Alcohol Use and Sexual Risk-Taking Behavior from Adolescence into Young Adulthood. Arch Sex Behav. 2015;
42. Patte KA, Leatherdale ST. A cross-sectional analysis examining the association between dieting behaviours and alcohol use among secondary school students in the COMPASS study. J Public Heal (United Kingdom). 2017;
43. Kwan M, Bobko S, Faulkner G, Donnelly P, Cairney J. Sport participation and alcohol and illicit drug use in adolescents and young adults: A systematic review of longitudinal studies. Addictive Behaviors. 2014.
44. SAS Institute. SAS version 9.4. SAS Institute Inc. 2012.
45. Patton GC, Hibbert M, Rosier MJ, Carlin JB, Caust J, Bowes G. Patterns of common drug use in teenagers. Aust J Public Health. 1995;19(4):393–9.
46. Bailey SL. Adolescents' multisubstance use patterns: The role of heavy alcohol and cigarette use. Am J Public Health. 1992;82(9):1220–4.
47. Yamaguchi K, Kandel DB. Patterns of drug use from adolescence to young adulthood: III. Predictors of progression. Am J Public Health. 1984;74(7):673–81.
48. Everett SA, Giovino GA, Warren CW, Crossett L, Kann L. Other substance use among high school students who use tobacco. J Adolesc Heal. 1998;23(98):289–96.
49. Carr S, O'Brien KS, Ferris J, Room R, Livingston M, Vandenberg B, et al. Child and adolescent exposure to alcohol advertising in Australia's major televised sports. Drug Alcohol Rev. 2016;
50. Low KG. Flourishing, substance use, and engagement in students entering college: A preliminary study. J Am Coll Heal. 2011;
51. Cooke R, Dahdah M, Norman P, French DP. How well does the theory of planned behaviour predict alcohol consumption? A systematic review and meta-analysis. Health Psychol Rev. 2016;
52. Norman P, Bennett P, Lewis H. Understanding binge drinking among young people: an application of the Theory of Planned Behaviour. Health Educ Res. 1998;
53. Johnston KL, White KM. Binge-Drinking: A Test of the Role of Group Norms in the Theory of Planned Behaviour. Psychol Health. 2003;
54. Ajzen I. The theory of planned behavior. Organ Behav Hum Decis Process. 1991;
55. Schlegel RP, DAvernas JR, Zanna MP, DeCourville NH, Manske SR. Problem Drinking: A Problem for the Theory of Reasoned Action? J Appl Soc Psychol. 1992;
56. Trucco EM, Colder CR, Wieczorek WF. Vulnerability to peer influence: A moderated mediation study of early adolescent alcohol use initiation. Addict Behav. 2011;
57. Cox WM, Klinger E. A motivational model of alcohol use. J Abnorm Psychol. 1988;
58. Social Issues Research Centre. Social and Cultural Aspects of Drinking [Internet]. 1998. Available from: http://www.sirc.org/publik/social_drinking.pdf
59. McKiernan A. Youth Sport Programs that Address Substance Use — An Environmental Scan. [Internet]. 2016. Available from: http://www.ccdus.ca/Resource Library/CCSA-Sport-Programs-Substance-Use-Education-Report-2016-en.pdf
60. Statistics Canada. Sport Participation 2010 [Internet]. 2013. Available from: http://publications.gc.ca/collections/collection_2013/pc-ch/CH24-1-2012-eng.pdf
61. Ajzen I. Attitudes and Persuasion. In: The Oxford Handbook of Personality and Social Psychology. 2012.

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 (1.28-20.6)**
	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 (≥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***

	Item No	Recommendation
Title and abstract	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 *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 autotomized 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	Explain how the study size was arrived at A complete-case analysis was used for this manuscript (N=8,344), resulting in a final analytic sample of 6,570 students.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why *Binge drinking* (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.
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding 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.
		(*b*) Describe any methods used to examine subgroups and interactions Using a stepwise modeling approach, we were able to evaluate any significant changes and interactions (if any) after including each variable.
		(*c*) Explain how missing data were addressed We used a complete case analysis.
		(*d*) If applicable, describe analytical methods taking account of sampling strategy N/A
		(*e*) Describe any sensitivity analyses 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.
Results		
Participants	13*	(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 A complete-case analysis was used for this manuscript (N=8,344), resulting in a final analytic sample of 6,570 students.
		(b) Give reasons for non-participation at each stage 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.
		(c) Consider use of a flow diagram

		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 brink 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 N/A
Discussion		
Key results	18	Summarise key results with reference to study objectives

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 metal 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

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2018-028558.R1
Article Type:	Research
Date Submitted by the Author:	25-Apr-2019
Complete List of Authors:	Butler, Alexandra; University of Waterloo, School of Public Health and Health Systems Romano, Isabella; University of Waterloo, School of Public Health and Health Systems Patte, Karen; Brock University Department of Health Sciences, Ferro, Mark; University of Waterloo, School of Public Health and Health Systems de Groh, Margaret; Public Health Agency of Canada, Applied Research Division Jiang, Ying; Public Health Agency of Canada, Applied Research Division Leatherdale, Scott T.; University of Waterloo, School of Public Health and Health Systems
Primary Subject Heading:	Public health
Secondary Subject Heading:	Mental health, Health policy, Epidemiology
Keywords:	MENTAL HEALTH, Depression & mood disorders < PSYCHIATRY, Substance misuse < PSYCHIATRY, High School, Child & adolescent psychiatry < PSYCHIATRY

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

Alexandra Butler, MSc[1], Isabella Romano, BSc[1], Karen A. Patte, PhD[2], Mark A. Ferro, PhD[1], Margaret de Groh, PhD[3], Ying Jiang, MSc, MD[3], Scott T. Leatherdale, PhD[1]

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

2 Department of Health Sciences, Brock University, St. Catharines, ON

3 Applied Research Division, Health Promotion and Chronic Disease Prevention Branch, Public Health Agency of Canada, Ottawa, ON

Corresponding author:
Alexandra Butler
University of Waterloo
200 University Avenue West
Lyle Hallman South, Room 1618H
Waterloo, Ontario, Canada
N2L 3G1
E-mail: alle.butler@uwaterloo.ca

Conflict of interest: None.

Word count: 3525

Abstract word count: 284

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 (Y_5[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 (α=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 (α=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 (α= 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 $\chi 2$ 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 brink 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 (51) as well as existing findings from the COMPASS MH-M pilot study (32), neither depression nor anxiety were correlated with binge drinking. However, unlike previous COMPASS research that found flourishing may protect against cannabis use (32), 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 (18,52) as underlying motives for alcohol consumption may represent important insight for intervention strategies.(53) In Canada, alcohol consumption exists as a normative social behaviour (54) that is common to many population(1), including youth.(20,21,24) 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 (55–58) and ultimately provide support for the *Theory of Planned Behaviour*. Schlegel et al. (58) 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.(20,59) 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.(60–63) 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 drinking. Adding this variable improved the predictive accuracy of our logistic models, as demonstrated by the concordance statistic. While sports team participation can contribute to positive health behaviours among youth (e.g. physical activity), patterns of excessive alcohol consumption among school athletes has been previously observed in research.(64)

The Canadian Centre on Substance Abuse recognizes that sports participation is linked to decreases in illicit drug use among youth, but the use of alcohol increases.(65) Youth between the ages of 15 to 19 years have the highest participation rates in sports.(66) Athletic involvement presents an optimal opportunity to influence youth by leveraging their team sport environments and implementing targeted prevention strategies.(65) Substance use is commonly initiated during adolescence, where

enrolment in sports is high, and as such, this is a critical period for substance use prevention efforts.(67) For instance, public health authorities may consider limiting or restricting alcohol promotion during events that may be attended by youth. Continued research is necessary within this domain as there remains a paucity of evidence on the risk of binge drinking within a team dynamic.

Given the varied predictors for alcohol and cannabis use among youth in the COMPASS MH-M pilot study, tailored approaches for each individual substance may be necessary. Although statistically insignificant, our findings present interesting results that suggest depression and anxiety may have different outcomes for alcohol consumption, and the directionality of associations observed may provide insight to public health researchers. Based heavily on the Theory of Planned Behaviour, existing psychosocial research suggests that persuading attitudes and norms to influence behaviour may prove effective at producing long-term changes.(68) Successful strategies may involve peer-to-peer mentoring or social norming campaigns given the influence peer groups have on attitudes towards alcohol consumption and, in turn, binge drinking behaviour.(20,21,24) Also, targeted intervention efforts implemented within the environment of a sports team dynamic may effectively influence health behaviours. Research should aim to examine substance use behaviours both separately and concurrently; further exploration may consider the possible association between mental health and co-occurring alcohol and cannabis use. Future waves of the COMPASS Study will be able to test these correlations and temporal relationships.

Strengths and Limitations

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

Conclusion

A large proportion of the study sample of grade 9 to 12 students reported binge drinking. About one-half and one-third of students reports clinically-relevant symptoms of depression and anxiety respectively, however, our research shows that mental health problems were likely not responsible for explaining patterns of alcohol consumption in our youth sample. Contrary to other COMPASS research on cannabis use, flourishing was not shown to moderate the relationship between depression or anxiety

and binge drinking in secondary school students. This new analysis of the COMPASS mental health data and youth alcohol use suggests that binge drinking among youth may be a product of social acceptability and normalcy, as opposed to a coping mechanism or contributor to mental health problems. Future research should aim to consider the role of social environments and alcohol consumption among youth, and where data is available, targeting binge drinking within a team dynamic and among different types of sports.

Declarations

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

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

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

Acknowledgements and funding
The COMPASS study has been supported by a bridge grant from the CIHR Institute of Nutrition, Metabolism and Diabetes (INMD) through the "Obesity – Interventions to Prevent or Treat" priority funding awards (OOP-110788; awarded to SL), an operating grant from the CIHR Institute of Population and Public Health (IPPH) (MOP-114875; awarded to SL), a CIHR project grant (PJT-148562; awarded to SL), a CIHR bridge grant (PJT-149092; awarded to KP/SL), a CIHR project grant (PJT-159693; awarded to KP), and by a research funding arrangement with Health Canada (#1617-HQ-000012; contract awarded to SL).

Authors' contributions
AEB and IR conceived the manuscript idea, performed the statistical analyses, drafted the manuscript, and revised the manuscript for content. IR, MAF, KAP, 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 have been listed above.

References

1. Public Health Agency of Canada. The Chief Public Health Officer's Report on the State of Public Health in Canada 2018: Preventing Problematic Substance Use in Youth [Internet]. Ottawa; 2018. Available from: https://www.canada.ca/en/public-health/corporate/publications/chief-public-health-officer-reports-state-public-health-canada/2018-preventing-problematic-substance-use-youth.html
2. Health Canada. Summary of results for the Canadian Student Tobacco, Alcohol and Drugs Survey 2016-17. [Internet]. 2018. Available from: https://www.canada.ca/en/health-canada/services/canadian-student-tobacco-alcohol-drugs-survey/2016-2017-summary.html
3. Welch KA, Carson A, Lawrie SM. Brain structure in adolescents and young adults with alcohol problems: Systematic review of imaging studies. Alcohol and Alcoholism. 2013.
4. Squeglia LM, Tapert SF, Sullivan E V., Jacobus J, Meloy MJ, Rohlfing T, et al. Brain development in heavy-drinking adolescents. Am J Psychiatry. 2015;
5. Hanson KL, Medina KL, Padula CB, Tapert SF, Brown S a. Impact of Adolescent Alcohol and Drug Use on Neuropsychological Functioning in Young Adulthood: 10-Year Outcomes. J Child Adolesc Subst Abuse. 2011;
6. Lo CC, Weber J, Cheng TC. A spatial analysis of student binge drinking, alcohol-outlet density, and social disadvantages. Am J Addict. 2013;
7. Larsen K, To T, Irving HM, Boak A, Hamilton HA, Mann RE, et al. Smoking and binge-drinking among adolescents, Ontario, Canada: Does the school neighbourhood matter? Heal Place. 2017;
8. Campbell CA, Hahn RA, Elder R, Brewer R, Chattopadhyay S, Fielding J, et al. The Effectiveness of Limiting Alcohol Outlet Density As a Means of Reducing Excessive Alcohol Consumption and Alcohol-Related Harms. American Journal of Preventive Medicine. 2009.
9. Wechsler H, Davenport A, Dowdall G, Moeykens B, Castillo S. Health and Behavioral Consequences of Binge Drinking in College: A National Survey of Students at 140 Campuses. JAMA J Am Med Assoc. 1994;
10. Miller JW, Naimi TS, Brewer RD, Jones SE. Binge Drinking and Associated Health Risk Behaviors Among High School Students. Pediatrics. 2007;
11. Marmorstein NR, Iacono WG, Malone SM. Longitudinal associations between depression and substance dependence from adolescence through early adulthood. Drug Alcohol Depend. 2010;
12. Hoel S, Eriksen BM, Breidablik H-J, Meland E. Adolescent alcohol use, psychological health, and social integration. Scand J Public Health. 2004;
13. Archie S, Zangeneh Kazemi A, Akhtar-Danesh N. Concurrent binge drinking and depression among Canadian youth: Prevalence, patterns, and suicidality. Alcohol. 2012;
14. Mason WA, Kosterman R, Haggerty KP, Hawkins JD, Redmond C, Spoth RL, et al. Dimensions of Adolescent Alcohol Involvement as Predictors of Young-Adult Major Depression. J Stud Alcohol Drugs. 2008;
15. Tapert SF, Caldwell L, Burke C. Alcohol and the adolescent brain: Human studies. Alcohol Res Heal [Internet]. 2004; Available from: http://go.galegroup.com/ps/i.do?ty=as&v=2.1&u=uniwater&it=DIourl&s=RELEVANCE&p=AONE&qt=SP~205~~IU~4~~SN~1535-7414~~VO~28&lm=DA~120040000&sw=w
16. Lamis DA, Malone PS, Langhinrichsen-Rohling J, Ellis TE. Body investment, depression, and alcohol use as risk factors for suicide proneness in college students. Crisis. 2010;
17. Lansford JE, Erath S, Yu T, Pettit GS, Dodge KA, Bates JE. The developmental course of illicit substance use from age 12 to 22: Links with depressive, anxiety, and behavior disorders at age 18. J Child Psychol Psychiatry Allied Discip. 2008;
18. Colder CR, Chassin L. The psychosocial characteristics of alcohol users versus problem users: Data

from a study of adolescents at risk. Dev Psychopathol. 1999;
19. Ajzen I. The theory of planned behavior. Organ Behav Hum Decis Process. 1991;
20. Brooks-Russell A, Simons-Morton B, Haynie D, Farhat T, Wang J. Longitudinal Relationship Between Drinking with Peers, Descriptive Norms, and Adolescent Alcohol Use. Prev Sci. 2014;
21. Jun M, Agley J, Huang C, Gassman RA. College Binge Drinking and Social Norms: Advancing Understanding Through Statistical Applications. J Child Adolesc Subst Abus. 2016;
22. Tanski SE, McClure AC, Li Z, Jackson K, Morgenstern M, Li Z, et al. Cued recall of alcohol advertising on television and underage drinking behavior. JAMA Pediatr. 2015;
23. Hastings G, Anderson S, Cooke E, Gordon R. Alcohol marketing and young people's drinking: A review of the research. Journal of Public Health Policy. 2005.
24. Ali MM, Amialchuk A, Nikaj S. Alcohol consumption and social network ties among adolescents: Evidence from Add Health. Addict Behav. 2014;
25. Smith LA, Foxcroft DR. The effect of alcohol advertising, marketing and portrayal on drinking behaviour in young people: Systematic review of prospective cohort studies. BMC Public Health. 2009;
26. Gordon R, Mackintosh AM, Moodie C. The impact of alcohol marketing on youth drinking behaviour: A two-stage cohort study. Alcohol Alcohol. 2010;
27. Clapp JD, Shillington AM, Segars LB. Deconstructing contexts of binge drinking among college students. Am J Drug Alcohol Abuse. 2000;
28. Nyqvist F, Pape B, Pellfolk T, Forsman AK, Wahlbeck K. Structural and Cognitive Aspects of Social Capital and All-Cause Mortality: A Meta-Analysis of Cohort Studies. Soc Indic Res. 2014;
29. Diener E, Wirtz D, Tov W, Kim-Prieto C, Choi D won, Oishi S, et al. New well-being measures: Short scales to assess flourishing and positive and negative feelings. Soc Indic Res. 2010;97(2):143–56.
30. Silva AJ, Caetano A. Validation of the Flourishing Scale and Scale of Positive and Negative Experience in Portugal. Soc Indic Res. 2013;110(2):469–78.
31. Keyes CLM. Mental Illness and/or Mental Health? Investigating Axioms of the Complete State Model of Health. J Consult Clin Psychol [Internet]. 2005;73(3):539–48. Available from: http://doi.apa.org/getdoi.cfm?doi=10.1037/0022-006X.73.3.539
32. Butler A, Patte KA, Ferro MA, Leatherdale ST. Interrelationships among depression, anxiety, flourishing, and cannabis use in youth. Addict Behav. 2019;
33. Leatherdale ST, Brown KS, Carson V, Childs RA, Dubin JA, Elliott SJ, et al. The COMPASS study: A longitudinal hierarchical research platform for evaluating natural experiments related to changes in school-level programs, policies and built environment resources. BMC Public Health. 2014;
34. Patte KA, Henderson J, Faulkner G, Elton-Marshall, Sabiston C, Bredin C, Battista K LS. Development of a mental health module for the COMPASS system: Improving youth mental health trajectories. [Internet]. Waterloo; 2017. Available from: www.compass.uwaterloo.ca
35. Patte KA, Bredin C, Henderson J, Elton-Marshall T, Faulkner G, Sabiston C, Battista K, Ferro M, Cole A, Doggett A, Godin K, Aleyan S, Butler A L ST. Development of a mental health module for the COMPASS system: Improving youth mental health trajectories. Part 2: Pilot test and focus group results. [Internet]. 2017. Available from: www.compass.uwaterloo.ca.
36. Patte KA, Bredin C, Henderson J, Elton-Marshall T, Faulkner G, Sabiston C, Battista K L ST. Development of a mental health module for the COMPASS system: Improving youth mental health trajectories. Part 1: Draft Development and Design [Internet]. 2017. Available from: www.compass.uwaterloo.ca.
37. Flicker S, Guta A. Ethical Approaches to Adolescent Participation in Sexual Health Research. J Adolesc Heal. 2008;
38. White VM, Hill DJ, Effendi Y. How does active parental consent influence the findings of drug-use

surveys in schools? Eval Rev. 2004;
39. Hollmann CM, Mcnamara JR. Considerations in the use of active and passive parental consent procedures. J Psychol Interdiscip Appl. 2010;
40. Elton-Marshall T, Leatherdale ST, Manske SR, Wong K, Ahmed R, Burkhalter R. Research methods of the youth smoking survey (YSS). Chronic Dis Inj Can. 2011;
41. Andresen EM, Malmgren J a, Carter WB, Patrick DL. Screening for depression in well older adults: evaluation of a short form of the CES-D (Center for Epidemiologic Studies Depression Scale). Am J Prev Med. 1994;
42. Zhang W, O'Brien N, Forrest JI, Salters KA, Patterson TL, Montaner JSG, et al. Validating a shortened depression scale (10 item CES-D) among HIV-Positive people in British Columbia, Canada. PLoS One. 2012;
43. Bradley KL, Bagnell AL, Brannen CL. Factorial validity of the center for epidemiological studies depression 10 in adolescents. Issues Ment Health Nurs. 2010;
44. Spitzer RL, Kroenke K, Williams JBW, Löwe B. A Brief Measure for Assessing Generalized Anxiety Disorder. Arch Intern Med. 2006;
45. Diener E, Wirtz D, Tov W, Kim-Prieto C, Choi D won, Oishi S, et al. New well-being measures: Short scales to assess flourishing and positive and negative feelings. Soc Indic Res. 2010;
46. Leatherdale ST. An examination of the co-occurrence of modifiable risk factors associated with chronic disease among youth in the COMPASS study. Cancer Causes Control. 2015;
47. O'Hara RE, Cooper ML. Bidirectional Associations Between Alcohol Use and Sexual Risk-Taking Behavior from Adolescence into Young Adulthood. Arch Sex Behav. 2015;
48. Patte KA, Leatherdale ST. A cross-sectional analysis examining the association between dieting behaviours and alcohol use among secondary school students in the COMPASS study. J Public Heal (United Kingdom). 2017;
49. Kwan M, Bobko S, Faulkner G, Donnelly P, Cairney J. Sport participation and alcohol and illicit drug use in adolescents and young adults: A systematic review of longitudinal studies. Addictive Behaviors. 2014.
50. SAS Institute. SAS version 9.4. SAS Institute Inc. 2012.
51. Low KG. Flourishing, substance use, and engagement in students entering college: A preliminary study. J Am Coll Heal. 2011;
52. Chassin L, Pitts SC, Prost J. Binge drinking trajectories from adolescence to emerging adulthood in a high-risk sample: Predictors and substance abuse outcomes. J Consult Clin Psychol. 2002;
53. Cox WM, Klinger E. A motivational model of alcohol use. J Abnorm Psychol. 1988;
54. Social Issues Research Centre. Social and Cultural Aspects of Drinking [Internet]. 1998. Available from: http://www.sirc.org/publik/social_drinking.pdf
55. Cooke R, Dahdah M, Norman P, French DP. How well does the theory of planned behaviour predict alcohol consumption? A systematic review and meta-analysis. Health Psychol Rev. 2016;
56. Norman P, Bennett P, Lewis H. Understanding binge drinking among young people: an application of the Theory of Planned Behaviour. Health Educ Res. 1998;
57. Johnston KL, White KM. Binge-Drinking: A Test of the Role of Group Norms in the Theory of Planned Behaviour. Psychol Health. 2003;
58. Schlegel RP, DAvernas JR, Zanna MP, DeCourville NH, Manske SR. Problem Drinking: A Problem for the Theory of Reasoned Action? J Appl Soc Psychol. 1992;
59. Trucco EM, Colder CR, Wieczorek WF. Vulnerability to peer influence: A moderated mediation study of early adolescent alcohol use initiation. Addict Behav. 2011;
60. Patton GC, Hibbert M, Rosier MJ, Carlin JB, Caust J, Bowes G. Patterns of common drug use in teenagers. Aust J Public Health. 1995;19(4):393–9.
61. Bailey SL. Adolescents' multisubstance use patterns: The role of heavy alcohol and cigarette use.

Am J Public Health. 1992;82(9):1220–4.
62. Yamaguchi K, Kandel DB. Patterns of drug use from adolescence to young adulthood: III. Predictors of progression. Am J Public Health. 1984;74(7):673–81.
63. Everett SA, Giovino GA, Warren CW, Crossett L, Kann L. Other substance use among high school students who use tobacco. J Adolesc Heal. 1998;23(98):289–96.
64. Carr S, O'Brien KS, Ferris J, Room R, Livingston M, Vandenberg B, et al. Child and adolescent exposure to alcohol advertising in Australia's major televised sports. Drug Alcohol Rev. 2016;
65. McKiernan A. Youth Sport Programs that Address Substance Use — An Environmental Scan. [Internet]. 2016. Available from: http://www.ccdus.ca/Resource Library/CCSA-Sport-Programs-Substance-Use-Education-Report-2016-en.pdf
66. Statistics Canada. Sport Participation 2010 [Internet]. 2013. Available from: http://publications.gc.ca/collections/collection_2013/pc-ch/CH24-1-2012-eng.pdf
67. Office of Research and Surveillance. Canadian Tobacco Alcohol and Drugs (CTADS): 2013 summary [Internet]. CTADS 2013. 2015. Available from: https://www.canada.ca/en/health-canada/services/canadian-tobacco-alcohol-drugs-survey/2013-summary.html
68. Ajzen I. Attitudes and Persuasion. In: The Oxford Handbook of Personality and Social Psychology. 2012.

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	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.
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 *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 autotomized 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	Explain how the study size was arrived at A complete-case analysis was used for this manuscript (N=8,344), resulting in a final analytic sample of 6,570 students.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why *Binge drinking* (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.
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding 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.
		(*b*) Describe any methods used to examine subgroups and interactions Using a stepwise modeling approach, we were able to evaluate any significant changes and interactions (if any) after including each variable.
		(*c*) Explain how missing data were addressed We used a complete case analysis.
		(*d*) If applicable, describe analytical methods taking account of sampling strategy N/A
		(*e*) Describe any sensitivity analyses 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.
Results		
Participants	13*	(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 A complete-case analysis was used for this manuscript (N=8,344), resulting in a final analytic sample of 6,570 students.
		(b) Give reasons for non-participation at each stage 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.
		(c) Consider use of a flow diagram

		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 brink 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 N/A
Discussion		
Key results	18	Summarise key results with reference to study objectives
		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 metal 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

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2018-028558.R2
Article Type:	Research
Date Submitted by the Author:	28-May-2019
Complete List of Authors:	Butler, Alexandra; University of Waterloo, School of Public Health and Health Systems Romano, Isabella; University of Waterloo, School of Public Health and Health Systems Patte, Karen; Brock University Department of Health Sciences, Ferro, Mark; University of Waterloo, School of Public Health and Health Systems de Groh, Margaret; Public Health Agency of Canada, Applied Research Division Jiang, Ying; Public Health Agency of Canada, Applied Research Division Leatherdale, Scott T.; University of Waterloo, School of Public Health and Health Systems
Primary Subject Heading:	Public health
Secondary Subject Heading:	Mental health, Health policy, Epidemiology
Keywords:	MENTAL HEALTH, Depression & mood disorders < PSYCHIATRY, Substance misuse < PSYCHIATRY, High School, Child & adolescent psychiatry < PSYCHIATRY

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

Alexandra Butler, MSc[1], Isabella Romano, BSc[1], Karen A. Patte, PhD[2], Mark A. Ferro, PhD[1], Margaret de Groh, PhD[3], Ying Jiang, MSc, MD[3], Scott T. Leatherdale, PhD[1]

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

2 Department of Health Sciences, Brock University, St. Catharines, ON

3 Applied Research Division, Health Promotion and Chronic Disease Prevention Branch, Public Health Agency of Canada, Ottawa, ON

Corresponding author:
Alexandra Butler
University of Waterloo
200 University Avenue West
Lyle Hallman South, Room 1618H
Waterloo, Ontario, Canada
N2L 3G1
E-mail: alle.butler@uwaterloo.ca

Conflict of interest: None.

Word count: 3634

Abstract word count: 284

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

such as social participation, enhanced self-esteem and autonomy, coping strategies, and accountability.(36)

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.(37–39) 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. Given that flourishing represents a modernized concept in the field of psychology, limited research currently existing exploring the impact positive wellbeing may have on overall substance use beahviours. However, recent findings examining the association between mental health problems and cannabis use demonstrated that 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.(40) As flourishing may offer protective effects against cannabis (40), additional research on the influence of overall wellbeing within other substance use domains (e.g., alcohol and tobacco use) is necessary to inform strategies for youth prevention or intervention programming.

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. Our analysis is intended as a follow-up to novel findings between cannabis and flourishing (40) and 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.(41) A new COMPASS mental health module (MH-M) was piloted in year 5 COMPASS data collections (Y_5[2016-2017]), as students' mental health was identified by stakeholders as a priority area for study.(42) 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.(42) 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.(41,43,44) A complete description of COMPASS methods is available in print (41) 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 (41), a strategy shown to be important for collecting robust data on self-reported risk behaviours such as substance use among youth.(45–47) 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 (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 (α=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 (α=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 (α= 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 χ2 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 brink 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

drinking. Adding this variable improved the predictive accuracy of our logistic models, as demonstrated by the concordance statistic. While sports team participation can contribute to positive health behaviours among youth (e.g. physical activity), patterns of excessive alcohol consumption among school athletes has been previously observed in research.(68)

The Canadian Centre on Substance Abuse recognizes that sports participation is linked to decreases in illicit drug use among youth, but the use of alcohol increases.(69) Youth between the ages of 15 to 19 years have the highest participation rates in sports.(70) Athletic involvement presents an optimal opportunity to influence youth by leveraging their team sport environments and implementing targeted prevention strategies.(69) Substance use is commonly initiated during adolescence, where enrolment in sports is high, and as such, this is a critical period for substance use prevention efforts.(71) For instance, public health authorities may consider limiting or restricting alcohol promotion during events that may be attended by youth. Continued research is necessary within this domain as there remains a paucity of evidence on the risk of binge drinking within a team dynamic.

Given the varied predictors for alcohol and cannabis use among youth in the COMPASS MH-M pilot study, tailored approaches for each individual substance may be necessary. Although statistically insignificant, our findings present interesting results that suggest depression and anxiety may have different outcomes for alcohol consumption, and the directionality of associations observed may provide insight to public health researchers. Based heavily on the Theory of Planned Behaviour, existing psychosocial research suggests that persuading attitudes and norms to influence behaviour may prove effective at producing long-term changes.(72) Successful strategies may involve peer-to-peer mentoring or social norming campaigns given the influence peer groups have on attitudes towards alcohol consumption and, in turn, binge drinking behaviour.(28,29,32) Also, targeted intervention efforts implemented within the environment of a sports team dynamic may effectively influence health behaviours. Research should aim to examine substance use behaviours both separately and concurrently; further exploration may consider the possible association between mental health and co-occurring alcohol and cannabis use. Future waves of the COMPASS Study will be able to test these correlations and temporal relationships.

Strengths and Limitations

The COMPASS Study is a unique data system that examines Canadian youth risk behaviours, and provides an ideal platform to evaluate multiple co-occurring behaviours and changes over time. Our results supplement existing evidence and advance knowledge on youth binge drinking behaviours. Important correlates identified in this study can be used to inform the creation of effective prevention and intervention programs. While this study provides a novel contribution to the literature, it is not without limitations. COMPASS uses a purposeful sampling method, and results are not representative of all Ontario and British Columbia youth or secondary schools. Since student data are self-reported, findings may be subject to reporting or recall bias, however, passive permission protocols have been implemented to improve sample representativeness and preserve anonymity. By employing a complete-case analysis, associations observed within this study may be underestimated. Data appeared to missing at random and information bias from non-differential misclassification is possible. Mental health items were measured based on 1-2 week recall and although scales employed in this study have been widely validated, these measures cannot be determine whether symptoms were chronic or acute. Moreover, depression and anxiety data were measured using scales and not diagnostic criteria. 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. Lastly, we were unable to establish binge drinking trajectories in relation to depression and anxiety given the cross-sectional

nature of the data. As COMPASS employs a longitudinal study design, follow-up research and examination of how behaviours evolve over time is possible once future waves of mental health data become available.

Conclusion

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

Declarations

Ethics approval and consent to participate

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

Consent for publication

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

Data statement:

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

Acknowledgements and funding

The COMPASS study has been supported by a bridge grant from the CIHR Institute of Nutrition, Metabolism and Diabetes (INMD) through the "Obesity – Interventions to Prevent or Treat" priority funding awards (OOP-110788; awarded to SL), an operating grant from the CIHR Institute of Population and Public Health (IPPH) (MOP-114875; awarded to SL), a CIHR project grant (PJT-148562; awarded to SL), a CIHR bridge grant (PJT-149092; awarded to KP/SL), a CIHR project grant (PJT-159693; awarded to KP), and by a research funding arrangement with Health Canada (#1617-HQ-000012; contract awarded to SL).

Authors' contributions

AEB and IR conceived the manuscript idea, performed the statistical analyses, drafted the manuscript, and revised the manuscript for content. IR, MAF, KAP, 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 have been listed above.

References

1. Public Health Agency of Canada. The Chief Public Health Officer's Report on the State of Public Health in Canada 2018: Preventing Problematic Substance Use in Youth [Internet]. Ottawa; 2018. Available from: https://www.canada.ca/en/public-health/corporate/publications/chief-public-health-officer-reports-state-public-health-canada/2018-preventing-problematic-substance-use-youth.html
2. Health Canada. Summary of results for the Canadian Student Tobacco, Alcohol and Drugs Survey 2016-17. [Internet]. 2018. Available from: https://www.canada.ca/en/health-canada/services/canadian-student-tobacco-alcohol-drugs-survey/2016-2017-summary.html
3. Welch KA, Carson A, Lawrie SM. Brain structure in adolescents and young adults with alcohol problems: Systematic review of imaging studies. Alcohol and Alcoholism. 2013.
4. Squeglia LM, Tapert SF, Sullivan E V., Jacobus J, Meloy MJ, Rohlfing T, et al. Brain development in heavy-drinking adolescents. Am J Psychiatry. 2015;
5. Hanson KL, Medina KL, Padula CB, Tapert SF, Brown S a. Impact of Adolescent Alcohol and Drug Use on Neuropsychological Functioning in Young Adulthood: 10-Year Outcomes. J Child Adolesc Subst Abuse. 2011;
6. Lo CC, Weber J, Cheng TC. A spatial analysis of student binge drinking, alcohol-outlet density, and social disadvantages. Am J Addict. 2013;
7. Larsen K, To T, Irving HM, Boak A, Hamilton HA, Mann RE, et al. Smoking and binge-drinking among adolescents, Ontario, Canada: Does the school neighbourhood matter? Heal Place. 2017;
8. Campbell CA, Hahn RA, Elder R, Brewer R, Chattopadhyay S, Fielding J, et al. The Effectiveness of Limiting Alcohol Outlet Density As a Means of Reducing Excessive Alcohol Consumption and Alcohol-Related Harms. American Journal of Preventive Medicine. 2009.
9. Wechsler H, Davenport A, Dowdall G, Moeykens B, Castillo S. Health and Behavioral Consequences of Binge Drinking in College: A National Survey of Students at 140 Campuses. JAMA J Am Med Assoc. 1994;
10. Miller JW, Naimi TS, Brewer RD, Jones SE. Binge Drinking and Associated Health Risk Behaviors Among High School Students. Pediatrics. 2007;
11. Marmorstein NR, Iacono WG, Malone SM. Longitudinal associations between depression and substance dependence from adolescence through early adulthood. Drug Alcohol Depend. 2010;
12. Hoel S, Eriksen BM, Breidablik H-J, Meland E. Adolescent alcohol use, psychological health, and social integration. Scand J Public Health. 2004;
13. Archie S, Zangeneh Kazemi A, Akhtar-Danesh N. Concurrent binge drinking and depression among Canadian youth: Prevalence, patterns, and suicidality. Alcohol. 2012;
14. Mason WA, Kosterman R, Haggerty KP, Hawkins JD, Redmond C, Spoth RL, et al. Dimensions of Adolescent Alcohol Involvement as Predictors of Young-Adult Major Depression. J Stud Alcohol Drugs. 2008;
15. Tapert SF, Caldwell L, Burke C. Alcohol and the adolescent brain: Human studies. Alcohol Res Heal [Internet]. 2004; Available from: http://go.galegroup.com/ps/i.do?ty=as&v=2.1&u=uniwater&it=DIourl&s=RELEVANCE&p=AONE&qt=SP~205~~IU~4~~SN~1535-7414~~VO~28&lm=DA~120040000&sw=w
16. Lamis DA, Malone PS, Langhinrichsen-Rohling J, Ellis TE. Body investment, depression, and alcohol use as risk factors for suicide proneness in college students. Crisis. 2010;
17. Lansford JE, Erath S, Yu T, Pettit GS, Dodge KA, Bates JE. The developmental course of illicit substance use from age 12 to 22: Links with depressive, anxiety, and behavior disorders at age 18. J Child Psychol Psychiatry Allied Discip. 2008;
18. Colder CR, Chassin L. The psychosocial characteristics of alcohol users versus problem users: Data

from a study of adolescents at risk. Dev Psychopathol. 1999;
19. Dir AL, Bell RL, Adams ZW, Hulvershorn LA. Gender Differences in Risk Factors for Adolescent Binge Drinking and Implications for Intervention and Prevention. Front psychiatry. 2017;
20. Bulloch AGM, Williams JVA, Lavorato DH, Patten SB. Trends in binge drinking in Canada from 1996 to 2013: a repeated cross-sectional analysis. C Open. 2016;
21. Johnston LD, O'Malley PM, Bachman JG, Schulenberg JE. Monitoring the future National survey results on drug use, 1975-2010. Institute for Social Research. 2011.
22. O'Hara RE, Cooper ML. Bidirectional Associations Between Alcohol Use and Sexual Risk-Taking Behavior from Adolescence into Young Adulthood. Arch Sex Behav. 2015;
23. Leatherdale ST. An examination of the co-occurrence of modifiable risk factors associated with chronic disease among youth in the COMPASS study. Cancer Causes Control. 2015;
24. Kwan M, Bobko S, Faulkner G, Donnelly P, Cairney J. Sport participation and alcohol and illicit drug use in adolescents and young adults: A systematic review of longitudinal studies. Addictive Behaviors. 2014.
25. Bellis MA, Hughes K, Morleo M, Tocque K, Hughes S, Allen T, et al. Predictors of risky alcohol consumption in schoolchildren and their implications for preventing alcohol-related harm. Subst Abus Treat Prev Policy. 2007;
26. Chung T, Creswell KG, Bachrach R, Clark DB, Martin CS. Adolescent Binge Drinking: Developmental Context and Opportunities for Prevention. Alcohol Res Curr Rev. 2018;
27. Ajzen I. The theory of planned behavior. Organ Behav Hum Decis Process. 1991;
28. Brooks-Russell A, Simons-Morton B, Haynie D, Farhat T, Wang J. Longitudinal Relationship Between Drinking with Peers, Descriptive Norms, and Adolescent Alcohol Use. Prev Sci. 2014;
29. Jun M, Agley J, Huang C, Gassman RA. College Binge Drinking and Social Norms: Advancing Understanding Through Statistical Applications. J Child Adolesc Subst Abus. 2016;
30. Tanski SE, McClure AC, Li Z, Jackson K, Morgenstern M, Li Z, et al. Cued recall of alcohol advertising on television and underage drinking behavior. JAMA Pediatr. 2015;
31. Hastings G, Anderson S, Cooke E, Gordon R. Alcohol marketing and young people's drinking: A review of the research. Journal of Public Health Policy. 2005.
32. Ali MM, Amialchuk A, Nikaj S. Alcohol consumption and social network ties among adolescents: Evidence from Add Health. Addict Behav. 2014;
33. Smith LA, Foxcroft DR. The effect of alcohol advertising, marketing and portrayal on drinking behaviour in young people: Systematic review of prospective cohort studies. BMC Public Health. 2009;
34. Gordon R, Mackintosh AM, Moodie C. The impact of alcohol marketing on youth drinking behaviour: A two-stage cohort study. Alcohol Alcohol. 2010;
35. Clapp JD, Shillington AM, Segars LB. Deconstructing contexts of binge drinking among college students. Am J Drug Alcohol Abuse. 2000;
36. Nyqvist F, Pape B, Pellfolk T, Forsman AK, Wahlbeck K. Structural and Cognitive Aspects of Social Capital and All-Cause Mortality: A Meta-Analysis of Cohort Studies. Soc Indic Res. 2014;
37. Diener E, Wirtz D, Tov W, Kim-Prieto C, Choi D won, Oishi S, et al. New well-being measures: Short scales to assess flourishing and positive and negative feelings. Soc Indic Res. 2010;97(2):143–56.
38. Silva AJ, Caetano A. Validation of the Flourishing Scale and Scale of Positive and Negative Experience in Portugal. Soc Indic Res. 2013;110(2):469–78.
39. Keyes CLM. Mental Illness and/or Mental Health? Investigating Axioms of the Complete State Model of Health. J Consult Clin Psychol [Internet]. 2005;73(3):539–48. Available from: http://doi.apa.org/getdoi.cfm?doi=10.1037/0022-006X.73.3.539
40. Butler A, Patte KA, Ferro MA, Leatherdale ST. Interrelationships among depression, anxiety,

flourishing, and cannabis use in youth. Addict Behav. 2019;
41. Leatherdale ST, Brown KS, Carson V, Childs RA, Dubin JA, Elliott SJ, et al. The COMPASS study: A longitudinal hierarchical research platform for evaluating natural experiments related to changes in school-level programs, policies and built environment resources. BMC Public Health. 2014;
42. Patte KA, Henderson J, Faulkner G, Elton-Marshall, Sabiston C, Bredin C, Battista K LS. Development of a mental health module for the COMPASS system: Improving youth mental health trajectories. [Internet]. Waterloo; 2017. Available from: www.compass.uwaterloo.ca
43. Patte KA, Bredin C, Henderson J, Elton-Marshall T, Faulkner G, Sabiston C, Battista K, Ferro M, Cole A, Doggett A, Godin K, Aleyan S, Butler A L ST. Development of a mental health module for the COMPASS system: Improving youth mental health trajectories. Part 2: Pilot test and focus group results. [Internet]. 2017. Available from: www.compass.uwaterloo.ca.
44. Patte KA, Bredin C, Henderson J, Elton-Marshall T, Faulkner G, Sabiston C, Battista K L ST. Development of a mental health module for the COMPASS system: Improving youth mental health trajectories. Part 1: Draft Development and Design [Internet]. 2017. Available from: www.compass.uwaterloo.ca.
45. Flicker S, Guta A. Ethical Approaches to Adolescent Participation in Sexual Health Research. J Adolesc Heal. 2008;
46. White VM, Hill DJ, Effendi Y. How does active parental consent influence the findings of drug-use surveys in schools? Eval Rev. 2004;
47. Hollmann CM, Mcnamara JR. Considerations in the use of active and passive parental consent procedures. J Psychol Interdiscip Appl. 2010;
48. Elton-Marshall T, Leatherdale ST, Manske SR, Wong K, Ahmed R, Burkhalter R. Research methods of the youth smoking survey (YSS). Chronic Dis Inj Can. 2011;
49. Andresen EM, Malmgren J a, Carter WB, Patrick DL. Screening for depression in well older adults: evaluation of a short form of the CES-D (Center for Epidemiologic Studies Depression Scale). Am J Prev Med. 1994;
50. Zhang W, O'Brien N, Forrest JI, Salters KA, Patterson TL, Montaner JSG, et al. Validating a shortened depression scale (10 item CES-D) among HIV-Positive people in British Columbia, Canada. PLoS One. 2012;
51. Bradley KL, Bagnell AL, Brannen CL. Factorial validity of the center for epidemiological studies depression 10 in adolescents. Issues Ment Health Nurs. 2010;
52. Spitzer RL, Kroenke K, Williams JBW, Löwe B. A Brief Measure for Assessing Generalized Anxiety Disorder. Arch Intern Med. 2006;
53. Diener E, Wirtz D, Tov W, Kim-Prieto C, Choi D won, Oishi S, et al. New well-being measures: Short scales to assess flourishing and positive and negative feelings. Soc Indic Res. 2010;
54. SAS Institute. SAS version 9.4. SAS Institute Inc. 2012.
55. Low KG. Flourishing, substance use, and engagement in students entering college: A preliminary study. J Am Coll Heal. 2011;
56. Chassin L, Pitts SC, Prost J. Binge drinking trajectories from adolescence to emerging adulthood in a high-risk sample: Predictors and substance abuse outcomes. J Consult Clin Psychol. 2002;
57. Cox WM, Klinger E. A motivational model of alcohol use. J Abnorm Psychol. 1988;
58. Social Issues Research Centre. Social and Cultural Aspects of Drinking [Internet]. 1998. Available from: http://www.sirc.org/publik/social_drinking.pdf
59. Cooke R, Dahdah M, Norman P, French DP. How well does the theory of planned behaviour predict alcohol consumption? A systematic review and meta-analysis. Health Psychol Rev. 2016;
60. Norman P, Bennett P, Lewis H. Understanding binge drinking among young people: an application of the Theory of Planned Behaviour. Health Educ Res. 1998;
61. Johnston KL, White KM. Binge-Drinking: A Test of the Role of Group Norms in the Theory of

Planned Behaviour. Psychol Health. 2003;
62. Schlegel RP, DAvernas JR, Zanna MP, DeCourville NH, Manske SR. Problem Drinking: A Problem for the Theory of Reasoned Action? J Appl Soc Psychol. 1992;
63. Trucco EM, Colder CR, Wieczorek WF. Vulnerability to peer influence: A moderated mediation study of early adolescent alcohol use initiation. Addict Behav. 2011;
64. Patton GC, Hibbert M, Rosier MJ, Carlin JB, Caust J, Bowes G. Patterns of common drug use in teenagers. Aust J Public Health. 1995;19(4):393–9.
65. Bailey SL. Adolescents' multisubstance use patterns: The role of heavy alcohol and cigarette use. Am J Public Health. 1992;82(9):1220–4.
66. Yamaguchi K, Kandel DB. Patterns of drug use from adolescence to young adulthood: III. Predictors of progression. Am J Public Health. 1984;74(7):673–81.
67. Everett SA, Giovino GA, Warren CW, Crossett L, Kann L. Other substance use among high school students who use tobacco. J Adolesc Heal. 1998;23(98):289–96.
68. Carr S, O'Brien KS, Ferris J, Room R, Livingston M, Vandenberg B, et al. Child and adolescent exposure to alcohol advertising in Australia's major televised sports. Drug Alcohol Rev. 2016;
69. McKiernan A. Youth Sport Programs that Address Substance Use — An Environmental Scan. [Internet]. 2016. Available from: http://www.ccdus.ca/Resource Library/CCSA-Sport-Programs-Substance-Use-Education-Report-2016-en.pdf
70. Statistics Canada. Sport Participation 2010 [Internet]. 2013. Available from: http://publications.gc.ca/collections/collection_2013/pc-ch/CH24-1-2012-eng.pdf
71. Office of Research and Surveillance. Canadian Tobacco Alcohol and Drugs (CTADS): 2013 summary [Internet]. CTADS 2013. 2015. Available from: https://www.canada.ca/en/health-canada/services/canadian-tobacco-alcohol-drugs-survey/2013-summary.html
72. Ajzen I. Attitudes and Persuasion. In: The Oxford Handbook of Personality and Social Psychology. 2012.

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	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.
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 *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 autotomized 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	Explain how the study size was arrived at A complete-case analysis was used for this manuscript (N=8,344), resulting in a final analytic sample of 6,570 students.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why *Binge drinking* (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.
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding 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.
		(*b*) Describe any methods used to examine subgroups and interactions Using a stepwise modeling approach, we were able to evaluate any significant changes and interactions (if any) after including each variable.
		(*c*) Explain how missing data were addressed We used a complete case analysis.
		(*d*) If applicable, describe analytical methods taking account of sampling strategy N/A
		(*e*) Describe any sensitivity analyses 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.
Results		
Participants	13*	(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 A complete-case analysis was used for this manuscript (N=8,344), resulting in a final analytic sample of 6,570 students.
		(b) Give reasons for non-participation at each stage 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.
		(c) Consider use of a flow diagram

		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 brink 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 N/A
Discussion		
Key results	18	Summarise key results with reference to study objectives
		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 metal 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.