Binge drinking and academic performance, engagement, aspirations, and expectations: a longitudinal analysis among secondary school students in the COMPASS study

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Abstract

Introduction: The longitudinal relationship between binge drinking and academic engagement, performance, and future aspirations and expectations was examined among a cohort of secondary school students.

Methods: In separate multinomial generalized estimating equations models, linked data from Year 1 (Y_1: 2012-2013), Year 2 (Y_2: 2013-2014), and Year 3 (Y_3: 2014-2015) of the COMPASS study (N = 27 112) were used to test the relative likelihood of responses to seven academic indices when binge drinking was initiated in varying frequencies, adjusting for gender, grade, race/ethnicity, tobacco use, and the individual mean of the predictor and all time-varying covariates.

Results: Among students who had never engaged in binge drinking at baseline, those who reported regular binge drinking at follow-up were relatively less likely to complete their homework, attend class, and value and achieve high grades, with more frequent binge drinking at follow-up generally resulting in larger relative risk ratios. Interestingly, shifting from "never" to "rare/sporadic" binge drinking one to two years later resulted in an increased relative risk of wanting to pursue all levels of postsecondary education. Beginning binge drinking on a "monthly" basis also increased the likelihood of college/ trade or bachelor degree ambitions, relative to high school, but not graduate/professional pathways; while degree aspirations were not associated with initiating weekly binge drinking.

Conclusions: Results suggest students who initiate binge drinking have poor school performance and engagement, which may interfere with achieving their future academic goals. This study reinforces the reasons substance use prevention should be considered an academic priority, as such efforts may also prove beneficial for educational achievement.

Keywords: binge drinking, alcohol, education, academic achievement, adolescents, school

Highlights

- Linked longitudinal data were used to test the relative likelihood of responses to seven academic indices when binge drinking was initiated in varying frequencies among a large cohort of secondary school students.
- Students who initiated regular binge drinking at follow-up were relatively less likely to complete their homework, to attend class, and to value and achieve high grades.
- Results indicate that adolescents who initiate binge drinking have a relatively higher risk of poor academic performance, and a lack of preparedness and engagement, while their future academic aspirations and expectations remain largely intact.
- Substance use prevention efforts may also prove beneficial for academic achievement and engagement.

about one-quarter of Ontario secondary school students reported binge drinking in the prior year, reaching up to 36.7% of students in grade 12.[5,7]

Binge drinking typically emerges around 13 to 15 years of age, peaking in the late teenage years or early 20s, followed by a slow decline.[4,8] Underage drinking is often deemed a common transitory behaviour, reflective of the increased propensity for risk-taking during this phase; however, experts argue that adolescents are particularly vulnerable to experiencing adverse consequences from alcohol use, and binge

Introduction

Adolescent substance use prevention is a key public health priority. Alcohol is the most frequently abused substance and is associated with the leading causes of death and serious injury (including motor vehicle accidents and suicide) among youth.[1,2] Among adolescents who use alcohol, the proportion who drink heavily appears higher than among adult drinkers, and tends to occur in a more episodic manner, with binge drinking—the consumption of large volumes of alcohol (i.e. five or more standard drinks) on a single occasion—acknowledged as the dominant pattern at this age.[2,3-5] Based on 2011–2012 estimates, one-third of Canadians in Grades 10 to 12 had engaged in binge drinking within the past year.[6] Similarly, in 2012–2013,

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consumption magnifies the risk.[1,3,9,10] The initiation of alcohol use occurs alongside changes in life roles and neurobiological maturation[11] and, therefore, has the potential to disrupt processes critical to the successful transition from childhood to adulthood. Educational achievement is an important determinant of how well this developmental stage is navigated. School failure, noncompletion, and truancy increase the likelihood of numerous problems later in life, including health-risk behaviours, criminality, violence, unemployment, and poverty.[12]

Alcohol use during adolescence may foster academic underachievement and disengagement, based on several cross-sectional studies[13,14] and selected longitudinal analyses.[15,16] For instance, heavy drinking among youth has been linked to lower school grades,[13-16] truancy,[13,17-19] and degree noncompletion.[20] However, many conflicting results also exist in the literature.[21,22] Moreover, reasons for the proposed link between substance use and education achievement remain poorly understood.

Direct causal theories point to the neurotoxicity of alcohol. Scholars widely agree that adolescence represents a period of heightened vulnerability, as the brain continues to undergo substantial development until at least the mid-20s.[3] Imaging research reveals reduced brain matter volume and integrity, as well as neurocognitive deficits (e.g. impaired memory and decision making), among heavy drinking adolescents compared to their non-/low drinking peers.[10,23,24] Frequent binge behaviour appears especially harmful, based on associations between the quantity and frequency of alcohol consumption with the persistence and degree of structural and functional abnormalities.[3,9-11] As the majority of studies have been cross-sectional in design, questions persist regarding whether reported neurocognitive differences predate (i.e. as genetic liabilities for substance use or pre-existing cognitive deficits) or result from alcohol use.[10,11]

Similarly, the direction of influence between substance use and academic achievement is uncertain. Problematic alcohol use is largely assumed to predict lower educational performance and degree attainment. In support, Latvala et al.[16] found both alcohol use and drinking to intoxication in adolescence predicted later school completion, and not vice-versa. In contrast, some evidence suggests reverse causation[14,15,17] or mutually reinforcing effects.[25,26] For example, Wang and Fredricks[26] found a bidirectional relationship between school engagement and youth substance use over time, and both factors predicted the likelihood of dropping out of school, although the independent effect of alcohol was not reported. Indirect or noncausal pathways have also been proposed.[21,22] Shared underlying risk factors such as mental health problems, low socio-economic status (SES), family instability, and a lack of parental monitoring and support may predispose adolescents to both underachievement and substance use. A similar theory contends drug use is simply one aspect of an overall pattern of problem behaviours.

Interpretation of the existing literature is also hindered by inconsistent measures of academic achievement or the reliance on degree completion as the only outcome measure. School dropout is likely preceded by a period of student apathy, declining grades, truancy, and/or disciplinary problems. Incorporating a range of academic outcomes would help to elucidate the potential mechanisms through which binge drinking may lead to school dropout. Also, focusing solely on degree attainment overlooks any adverse influences of binge drinking on school performance and engagement among students who manage to graduate. Past research on alcohol use may fail to adequately capture the impact on academic outcomes experienced by adolescents who binge drink, the dominant pattern of alcohol use at this age. To help clarify the above discussed ambiguities, the current study tested multiple models among a large cohort of secondary school students with the initiation of binge drinking in varying frequencies predicting several indices of educational engagement, performance, aspirations, and expectations.

Methods

Design

The COMPASS study is a prospective cohort study designed to collect hierarchical longitudinal data from a sample of Grade 9 to 12 secondary school students and the schools they attend in Ontario and Alberta, Canada.[28] The current study reports longitudinal student-level linked data from Year 1 (Y_1: 2012–2013), Year 2 (Y_2: 2013–2014), and Year 3 (Y_3: 2014–2015). A full description of the COMPASS study methods is available in print[27] or online (www.compass.uwaterloo.ca). The University of Waterloo Office of Research Ethics (ORE #17264) and appropriate school board committees approved all procedures.

Participants

In Y_1, 43 schools were purposefully recruited because they permitted use of active-information passive-consent parental permission protocols,[28] which is critical for collecting robust data on youth substance use.[29] Students could decline to participate at any time. In Y_1, data were collected from 24 173 Grade 9-12 students (80.2% participation rate) in 43 schools. Y_2 data were collected from 23 424 Grade 9-12 students (78.2% participation rate) in the same 43 schools, and an additional 46 schools were recruited into the study where data were collected from 21 874 Grade 9-12 students (80.2% participation rate). Y_3 data were collected from 42 355 Grade 9-12 students (78.7% participation rate) in 87 schools (two schools of the 43 Y_1 schools dropped out between Y_2 and Y_3). Missing respondents resulted primarily from scheduled spares/free periods or absenteeism during data collection.

To explore longitudinal changes, we linked Y_1, Y_2, and Y_3 student-level data within schools. The process of linking the student data across waves is described in more detail by Qian and colleagues.[30] Due to the rolling sample design,[28] it was not possible to link the Grade 12 students in Y_1 or the Grade 12 students in Y_2 that graduated, or the Grade 9 students that were newly admitted to schools in Y_3. The other main reasons for non-linkage included students transferring schools, absent or on spares, dropping out of school, or inaccurate or missing data provided in the linkage measures. Overall, 27 329 students were successfully linked for at least two years of the study (linkage rates for Y_1, Y_2, and Y_3 were 51.4%, 57%, and 50%, respectively), with 18.0% (n = 4914) completing the questionnaire in all three years. Only students that were linked for two or three waves of data were included in the analyses. Missing data were treated as missing at random and excluded on an analysis-by-analysis basis. Based on previous analyses,[30] students with better academic performance were less likely to be missing; however, results of a preliminary longitudinal regression analysis (generalized estimating equations [GEE] model)

supported our assumption that the transition/change in the academic outcomes over study waves were similar for missing and nonmissing groups, with the exception of the homework completion variable. Homework completion may be subject to nonresponse bias and should be interpreted with caution.

Data collection tool

The student-level questionnaire for COMPASS (Cq) collects individual student data pertaining to multiple behavioural domains (substance use, physical activity, diet, etc.), correlates, and demographic characteristics. In each school, the Cq was used to collect whole-school samples during class time. The Cq items were based on national standards or current national public health guidelines as described elsewhere.[28] The cover page of the Cq contains measures required to create a unique self-generated code for each respondent in a school to ensure the anonymity of the survey participants, while still allowing COMPASS researchers to link each student's unique identifier data over multiple years.

Measures

Binge drinking
To assess *binge drinking*, students were asked "In the last 12 months, how often did you have 5 drinks of alcohol or more on one occasion?". Responses were recoded as "never" if students reported they had never drunk alcohol, had only had a sip of alcohol, had never had 5 or more drinks on one occasion, or had not done so within the past 12 months. Participants were considered to binge drink on a "rare/sporadic" basis if they responded "less than once a month", on a "monthly" basis if they responded "once a month" or "two to three times a month", and "weekly" if they engaged in binge drinking "once a week" or "two to five times a week." Students who responded "daily or almost daily" binge drinking over the last 12 months were deemed probable misreports and excluded. While the available Cq measure does not align with the low-risk drinking guideline for binge drinking among females,[31] it is consistent with previous research[5,7,28] and national surveillance tools.[32]

Academic variables
Academic aspirations and *expectations* were assessed by asking, "What is the highest level of education you would *like* to get?"

and "What is the highest level of education you *think* you will get?" respectively.

To measure *academic performance*, students were asked "In your current or most recent Math course, what is your approximate overall mark?" The same question was used to assess English marks.

The following survey items were intended to reflect different aspects of *school engagement*. The value students assigned to school performance was assessed by how strongly they agreed with the statement, "Getting good grades is important to me". Truancy was determined by the number of classes skipped when not supposed to in the last four weeks. Lastly, participants were asked, "how often do you go to class without your homework complete?"

Spearman rank correlation coefficients were calculated to examine correlations between the academic variables. Overall, the coefficients indicated significant weak correlations in the expected direction between the various indices (see Table 1). Response categories for all academic variables are shown in Table 2. Some categories were collapsed if the number of responses was insufficient to be modelled.

Covariates
All regression models were adjusted for student-reported gender (male, female), grade (9-12), and race/ethnicity (White, Black, Asian, Hispanic, off-reserve Aboriginal, other/mixed/missing), given evidence of variations in drinking behaviour and in educational engagement, performance, and/or degree attainment among these sociodemographic groups.[2,33-35] Models also adjusted for tobacco cigarette use (current, past, never), as it tends to cluster with many suggested confounders (e.g. parental education and substance use, as well as low SES). Age was not included due to the high correlation with grade, which is a more meaningful indicator for school-based prevention planning.

Statistical analysis

Descriptive statistics were calculated using statistical package SAS version 9.4 (SAS Institute Inc., Cary, NC, USA) for responses at first participation in the COMPASS study (baseline).

Multinomial GEE models were used to explain the within-individual associations of each of the academic variables with binge drinking. Models require specification of marginal regression models and correlations. Suppose there are J response categories and the Jth category is the baseline. We modeled the marginal regression model as a baseline category logit model, such that,

$$\log \Pr\ Y_{it} = j | x_{it} \Pr Y_{it} = J | x_{it} = \beta_{0j} + \beta'_{1j}\ x_{it}\ \ for\ j = 1, 2,\ and\ J - 1,$$

where Y_{it} is the tth observation for student i, x_{it} is the vector of covariates or predictors, and β_{0j} and β_{1j} are the jth category

TABLE 1
Spearman rank correlation coefficients between the academic variables in the three-year linked sample of secondary school students in the COMPASS study, 2012–2015

	1	2	3	4	5	6
1. Level of education would *like* to get						
2. Level of education *expect* to get	0.72*					
3. How often goes to class *without* homework complete	0.09*	−0.11*				
4. Number of classes skipped in last 4 weeks	−0.12*	−0.14*	0.23*			
5. "Getting good grades is important to me"	−0.20*	−0.23*	0.29*	0.20*		
6. English course mark	−0.21*	−0.24*	0.20*	0.13*	0.34*	
7. Math course mark	−0.18*	−0.21*	0.20*	0.13*	0.30*	0.44*

Notes: Year 1: 2012–2013, year 2: 2013–2014 and year 3: 2014–2015.
For the level of education students would *like* to or *expect* to get, higher numbers indicate higher degrees (i.e. in the order of: high school, college/trade/vocational, bachelor's, graduate/professional). For other variables, higher numbers indicate lower English or Math marks, or that students report skipping classes or not completing their homework more often. Student responses are pooled for all available data for the three years of available data, as each year closely resembled the other years when calculated separately.

*$p < .0001$.

TABLE 2
Baseline frequency statistics of binge drinking, academic, and covariate measures in the three-year linked sample of secondary school students in the COMPASS study, 2012–2015

	Females n = 14 323	Males n = 12 789	Chi-square
	n (%)[a]	n (%)[a]	
Grade			
9	6301 (44.0)	5747 (44.9)	
10	4494 (31.4)	3862 (30.2)	p < .0001
11	3319 (23.2)	2839 (22.2)	
12	209 (1.5)	341 (2.7)	
Race/ethnicity			
White	11 060 (77.2)	9646 (75.4)	
Black	409 (2.9)	554 (4.3)	
Asian	761 (5.3)	677 (5.3)	p < .0001
Off-reserve Aboriginal	374 (2.6)	334 (2.6)	
Hispanic	257 (1.8)	274 (2.1)	
Other/mixed/missing	1462 (10.2)	1304 (10.2)	
Tobacco use (cigarettes only)			
Current	273 (1.9)	355 (2.8)	
Past	64 (0.5)	56 (0.4)	p < .0001
Never	13 986 (97.6)	12 378 (96.8)	
Binge drinking frequency			
Never	8879 (62.0)	8242 (64.5)	
Rare/sporadic	3378 (23.6)	2634 (20.6)	p < .0001
Monthly	1691 (11.8)	1502 (11.7)	
Weekly	375 (2.6)	411 (3.2)	
Level of education would *like* to get			
High school equivalency or less	451 (4.0)	596 (5.9)	
College diploma/trade/vocational	1929 (17.0)	3078 (30.3)	p < .0001
University bachelor's degree	2386 (21.0)	2267 (22.3)	
Master's/PhD/law/medical/teacher's college	6582 (58.0)	4223 (41.6)	
Level of education *expect* to get			
High school equivalency or less	688 (6.3)	702 (6.9)	
College diploma/trade/vocational	2563 (23.6)	3576 (35.3)	p < .0001
University bachelor's degree	3059 (28.2)	2764 (27.3)	
Master's/PhD/law/medical/teacher's college	4557 (41.9)	3093 (30.5)	

are included in the model.[37] This technique was also applied to other time-varying covariates.

To evaluate the impact of within-school association, Kendall's tau coefficients were calculated for all pairs of observations from different students within the same school for all academic variables. The values ranged from -0.013 to -0.001, which suggested weak within-school association. In contrast, Kendall's tau coefficients for all pairs of observations from the same student (range 0.32, 0.60) indicated strong within-individual association. In the model, the within-individual association at the student level were constructed using local odds ratios.

The computation was implemented using the R package *multgee*.[38] More details can be found in Touloumis et al.[39,40] Separate models were constructed for the effect of binge drinking on each academic outcome variable. The total sample (i.e. students linked for at least two waves of data) was included in all models. To simplify our tables, and to inform prevention strategies, only the relative results for students who went from "never" binge drinking at baseline to the other binge drinking groups at follow-up are presented. Models were adjusted for gender, grade, race/ethnicity, and tobacco use.

Results

Descriptive statistics

After excluding students with probable misreports (i.e. "daily or almost daily" binge drinking over the last year; n = 217), a final sample of 27 112 remained for the analyses. Table 2 presents the baseline frequency statistics in the first year that students participated. Few students had used tobacco, and the majority identified as White, and 52.8% as female. At baseline, 38.0% of females and 35.6% of males had engaged in binge drinking, with about 15% doing so once a month or more. Baseline responses to the academic variables were encouraging, with most students valuing good grades, achieving high marks, attending classes, regularly completing their homework, and aspiring to pursue postsecondary education.

The cross-sectional distribution of student responses to the binge drinking frequency measure by year of data collection is presented in Figure 1 for the total sample,

specific parameter vectors. Person-mean centering is used for time-varying predictors to disaggregate between-person and within-person effects for the time-varying predictor.[36] As binge-drinking status has multiple categories, we first transformed the categorical predictor into multiple dummy variables and then calculated their personal means across time. Those dummy variables and their personal means

Baseline frequency statistics of binge drinking, academic, and covariate measures in the three-year linked sample of secondary school students in the COMPASS study, 2012–2015

	Females n = 14 323	Males n = 12 789	Chi-square
	n (%)[a]	n (%)[a]	
Math course mark			
90–100%	2907 (20.8)	2356 (19.0)	
80–89%	4479 (32.0)	3765 (30.4)	
70–79%	3422 (24.4)	3176 (25.6)	p < .0001
60–69%	1795 (12.8)	1764 (14.2)	
Less than 60%	1401 (10.0)	1343 (10.8)	
English course mark			
90–100%	2259 (16.2)	1053 (8.6)	
80–89%	6097 (43.6)	4201 (34.1)	
70–79%	3932 (28.2)	4468 (36.3)	p < .0001
60–69%	1208 (8.7)	1765 (14.3)	
Less than 60%	469 (3.4)	822 (6.7)	
"Getting good grades is important to me"			
Disagree/strongly disagree	411 (2.9)	719 (5.8)	
Agree	4790 (33.9)	5436 (43.6)	p < .0001
Strongly agree	8924 (63.2)	6304 (50.6)	
How often goes to class *without* homework complete			
Never	3454 (24.5)	2448 (19.6)	
Seldom	7807 (55.4)	6782 (54.3)	p < .0001
Often	1959 (13.9)	2245 (18.0)	
Usually	869 (6.2)	1016 (8.1)	
Number of classes skipped in last 4 weeks			
0	11 376 (80.5)	10 392 (83.1)	
1–5	2535 (18.0)	1891 (15.1)	p < .0001
6+	204 (1.5)	223 (1.8)	

Notes: Year 1: 2012–2013, year 2: 2013–2014 and year 3: 2014–2015.
Student responses are reported for the first year a respondent participated.

[a] Numbers may not add to total because of missing values.

and in Figure 2 for students with all three years of linked data available. The transition of students between binge drinking categories from Y_1 to Y_2 and from Y_2 to Y_3 is presented in Table 3.

Multinomial GEE models

Table 4 presents the relative risk ratios (RRRs) of students reporting college, university, or graduate/professional academic aspirations and expectations over "high school equivalency or less", when student reports shifted from "never" binge drinking at baseline to "rare/sporadic", "monthly", or "weekly" in the one to two years following. Reported results are adjusted for student-identified gender, race/ethnicity, and grade. Students who began binge drinking on a rare/sporadic basis at follow-up were more likely to report *aspirations* to pursue all levels of higher education rather than aim to discontinue their education at high school, but were no more or less likely to report different degree *expectations*. Starting to binge drink monthly in the following year or two increased the odds of college/trade school and university bachelor ambitions and expectations after high school, but did not impact the likelihood of reporting graduate/professional degree goals or expectations. The initiation

of binge drinking on a weekly basis at follow-up did not influence the relative likelihood of the degree students aspired or expected to achieve.

Table 4 also presents the academic engagement and performance models, adjusted for the covariates. Students who went from never binge drinking at baseline to regular binge drinking at follow-up were more likely to attend class with incomplete homework, skip class, achieve high marks, and disagree that good grades were important to them, than to complete their homework, attend class, report marks less than 60%, and strongly agree that good grades were important to them. Students who initiated rare/sporadic binge drinking were also relatively less likely to complete their homework, achieve high English marks, and agree that good grades were important, in comparison to the reference category response options.

Overall, based on the RRRs, the more frequent the initiated binge drinking, the lower the likelihood of high academic performance and engagement.

Discussion

Previous research has been inconsistent on the link between alcohol use and academic achievement. To ascertain whether the findings were similar among high-risk drinkers—the population typically targeted by prevention strategies—the current study examined how the initiation of binge drinking during adolescence impacts educational performance, engagement, and future goals and expectations. Among a large cohort of secondary school students in the COMPASS study, linked longitudinal data was used to test the relative likelihood of different responses to various academic indices when participants went from never binge drinking at baseline to reporting varying frequencies of binge drinking one or two years later.

As expected, students who started regular binge drinking were more likely to report academic disengagement and poor performance than to regularly attend class, complete their homework, consider good grades important, and achieve high marks. Results lend support to a step-wise relationship; that is, the more frequent the binge drinking reported at follow-up, the lower the likelihood of being engaged and performing well in school. On the other hand, when asked about their academic

FIGURE 1
Binge drinking frequency in the total three-year linked sample of secondary school students in the COMPASS study
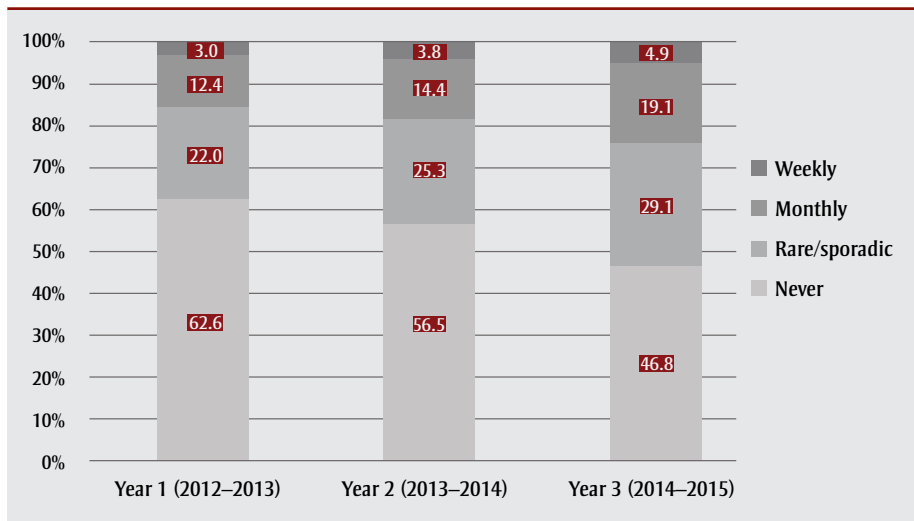

Note: Sample size is 12 317 in year 1, 25 675 in year 2 and 21 088 in year 3.

goals, youth who began binge drinking on a rare/sporadic or monthly basis had a greater relative risk of reporting ambitions and expectations to pursue higher education past high school. Students who commenced weekly binge drinking were no more or less likely to indicate postsecondary degree ambitions. Similarly, the degree-level students expected to achieve did not appear to change when binge drinking was initiated at a rare/sporadic or weekly frequency.

The multiple academic indices and range of binge drinking frequencies included in this study, and the varying findings among the models, shed light on potential sources of disagreement in past research, which was often limited to dichotomous alcohol use variables or single academic outcome measures. The majority of the various academic indices included in the current study had weak correlations. Wormington and colleagues[41] argue literature inconsistencies resulted from aggregation of qualitatively different types of educational motives. Past conflicting results tend to centre around degree attainment,[21,22] whereas findings with school engagement have been more consistent, although many
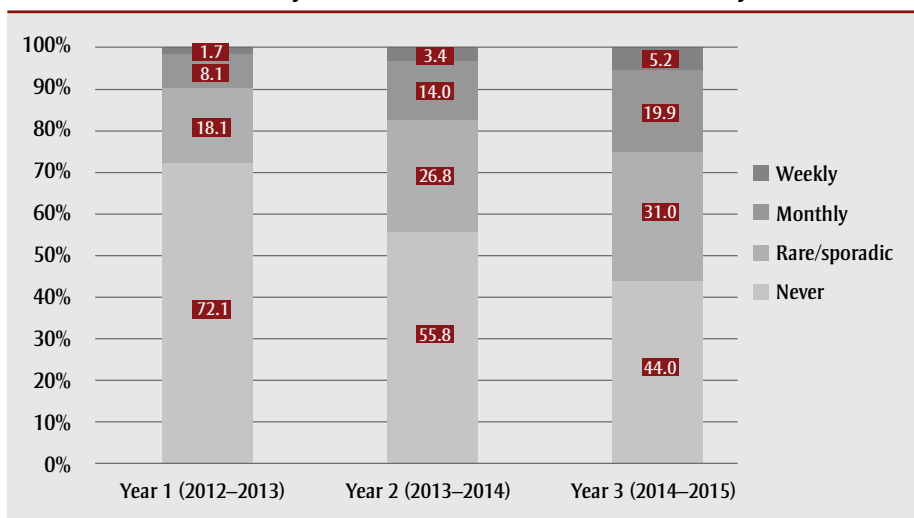
of these studies only included truancy to indicate disengagement.[13,17,18] In the current study, while students who started binge drinking had the anticipated greater risk of disengagement and poor performance, which increased with the initiation of more frequent binge drinking, results of the academic expectations and aspirations models were null or in the opposing direction. In other words, although engagement and performance suffered, the future ambitions to pursue higher education appeared to remain largely intact when students commenced binge drinking. Consistent with this finding, the academic expectation and aspiration variables had relatively weaker correlations with the indicators of academic engagement and performance. Whether the disengagement and poor performance prevents students from achieving their educational goals may depend on whether binge drinking is sustained,[42] supporting the need for early intervention efforts targeting heavy alcohol users.

Compared to other substances of abuse, the literature demonstrates less robust or consistent links between alcohol and education.[21,22,27] Some experts theorize alcohol is more compatible with academic achievements than other drug use.[22] Drinking is legal and socially accepted, or even encouraged, in certain circles. The models of students' academic aspirations to pursue postsecondary school are interesting, as alcohol is often affiliated with the culture of higher education. Some evidence suggests the perception of more permissive drinking cultures contributes to heavier alcohol intakes, and postsecondary students are shown to overestimate their classmates' alcohol consumption[43] and to have higher drinking frequencies than their peers not attending school.[44] In light of these findings, interventions have been developed to alter campus culture and correct misperceptions of student drinking norms.[45] Similar programs may be valuable earlier, as it is plausible that perceptions of postsecondary cultures contribute to drinking among adolescents planning to pursue scholarly paths.

Alternatively, drawing from the drinking motives literature, students may binge drink to cope with the pressure to succeed academically. It is plausible that distress related to school pressures, particularly higher-educational aspirations, may drive binge drinking via coping motives, which in turn, adversely

FIGURE 2
Binge drinking frequency by study wave among secondary school students with three years of linked data from the COMPASS study

Note: Sample size is 4856.

TABLE 3
Transition of secondary school students' binge drinking frequency
from year 1 to year 2 and from year 2 to year 3 of the COMPASS study

Year 1	Year 2				
	Never	**Rare/sporadic**	**Monthly**	**Weekly**	**Total**
	n (%)	**n (%)**	**n (%)**	**n (%)**	
Never	4629 (68.2)	1559 (23.4)	469 (6.7)	84 (1.6)	6741
Rare/sporadic	373 (14.1)	1246 (51.1)	720 (29.6)	112 (5.1)	2451
Monthly	87 (5.1)	346 (25.3)	722 (53.3)	209 (16.3)	1364
Weekly	13 (3.5)	38 (11.9)	110 (33.9)	163 (50.7)	324
Total	**5102**	**3189**	**2021**	**568**	**10 880**
Year 2	Year 3				
	Never	**Rare/sporadic**	**Monthly**	**Weekly**	**Total**
	n (%)	**n (%)**	**n (%)**	**n (%)**	
Never	8382 (69.2)	2755 (22.7)	845 (7.0)	139 (1.2)	12 121
Rare/sporadic	733 (15.6)	2311 (50.2)	1378 (30.0)	179 (3.9)	4601
Monthly	166 (7.1)	560 (23.9)	1242 (53.0)	380 (16.2)	2348
Weekly	42 (7.2)	66 (11.4)	224 (38.6)	249 (42.9)	581
Total	**9323**	**5692**	**3689**	**947**	**19 651**

Note: Year 1: 2012–2013, year 2: 2013–2014 and year 3: 2014–2015.

impacts school performance and engagement. Some evidence suggests increased drinking predicts declining socio-emotional functioning, which has negative implications on academic performance.[15] In addition to a mediator role, poor mental health or emotional dysregulation likely represents a common risk factor, placing students at greater risk of both problematic alcohol use and academic underachievement.[34] Some studies indicate the effects of substance use on educational variables are attenuated or no longer significant after adjustment for mental health;[19] however, King *et al.*[46] found support for substance use as both a mediator and a marker of a broader spectrum of problems which reduce academic achievement.

Future research should confirm the current study results with control for student mental health, as well as other potential confounders, such as parental substance use, education, and income. Adolescents from low-SES households may have greater risk of exposure to substance abuse by family members, and lack role models with higher degrees. Moreover, parents with lower education or incomes potentially provide less support for school work and scholarly pursuits due to longer and less flexible work hours, lower perceived competence, or

insufficient financial resources to support scholarly goals. Interestingly, Roebroek and Koning[25] found a bidirectional relationship between alcohol consumption and school engagement, but only among adolescents with lower levels of parental support. Tobacco use was adjusted for in the models as it tends to cluster with many proposed confounders. Indeed, classification as a current smoker had the largest adverse effect on the academic outcomes in all models, relative to binge drinking status and the other covariates (results not shown). Students who identified as female, in higher grades, and/or as Aboriginal or Black were also more vulnerable to academic disengagement, poorer performance, and a lack of postsecondary degree aspirations and expectations, relative to their counterparts who reported they were male, in lower grades, and/or White, respectively (results not shown).

Considering the prevalence of binge drinking among youth[5-7] and importance of educational achievement to their future opportunities,[12] increased prevention efforts are of critical importance. Schools have been identified as the ideal setting for such strategies given the ability to reach the large majority of the population, regardless of SES. Targeted efforts at marginalized groups more vulnerable to

academic underachievement may be warranted. Based on the current study, school-based prevention programs may ultimately benefit not only students' well-being, but their academic engagement and performance. Some evidence indicates enhancing recognition of the hazards of alcohol use may assist in reducing adolescent binge drinking, and in turn, improve educational attainment.[47] For example, young teenagers with high risk perceptions of substance use were less likely to binge drink as high school seniors, which was associated with greater chances of graduating from high school and attending college.[48]

Strengths and limitations

Primary strengths of the study include the large sample and linked data, as well as the multiple academic indices and range of binge drinking frequencies; Nonetheless, certain limitations should be taken into account when interpreting results. While the longitudinal design and statistical procedures strengthen inferences, bidirectional effects were not tested. Secondly, no data was available on certain suggested confounders (e.g. mental health, SES, family support, parental substance use). Also, although self-report methods are considered reliable and valid approaches to measuring alcohol consumption,[49] recall bias and underreporting remain possible, and linkage rates are lower for students who use substances and are less engaged in school.[30] Missing data were treated as missing at random and excluded based on analyses indicating the transition in academic outcomes was similar in missing and nonmissing samples, with the exception of the homework completion outcome, which may be subject to nonresponse bias, and should be interpreted with caution. To encourage honest reporting, and improve participation and representativeness, passive-consent procedures were used, and students were not asked to provide their names, were assured confidentiality, and were not made aware of the data collection date ahead of time.[50] Lastly, to be consistent with previous research[5,7] and tools,[32] binge drinking was defined as consuming five or more alcoholic beverages on one occasion and assessed with reference to the past 12 months; however, measures using shorter timeframes can be more reliable,[49] and lower cut-off points have been suggested for females and/or youth.[2]

TABLE 4
Multinomial GEE models of secondary school student binge drinking with academic performance, engagement, and aspirations in years 1 to 3 of the COMPASS study

	Binge drinking frequency (vs. Never)		
	Rare/sporadic	**Monthly**	**Weekly**
	RRRᵃ (95% CI)	**RRRᵃ (95% CI)**	**RRRᵃ (95% CI)**
Level of education would like to get (vs. High school equivalency or less) (n = 20 458)ᵇ			
College/trade/vocational	1.38 (1.13–1.68), *p* = .0014	1.39 (1.08–1.78), *p* = .0095	1.35 (0.93–1.97), *p* = .1128
Bachelor's	1.43 (1.18–1.72), *p* = .0002	1.39 (1.09–1.77), *p* = .0089	1.46 (1.00–2.12), *p* = .0514
Graduate/professional	1.27 (1.06–1.52), *p* = .0098	1.25 (0.99–1.59), *p* = .0598	1.08 (0.75–1.55), *p* = .6832
Level of education expect to get (vs. High school equivalency or less) (n = 19 869)			
College/trade/vocational	1.16 (0.98–1.37), *p* = .0753	1.32 (1.06–1.63), *p* = .0116	1.28 (0.92–1.79), *p* = .1475
Bachelor's	1.14 (0.98–1.34), *p* = .0950	1.28 (1.04–1.57), *p* = .0213	1.16 (0.83–1.62), *p* = .3803
Graduate/professional	1.08 (0.93–1.26), *p* = .3115	1.16 (0.95–1.42), *p* = .1408	1.05 (0.76–1.47), *p* = .7536
How often do you go to class without your homework complete? (vs. Never) (n = 26 310)			
Seldom	1.38 (1.21–1.58), *p* < .0001	1.90 (1.58–2.28), *p* < .0001	2.33 (1.75–3.11), *p* < .0001
Often	1.40 (1.27–1.54), *p* < .0001	1.59 (1.39–1.83), *p* < .0001	1.87 (1.48–2.37), *p* < .0001
Usually	1.19 (1.10–1.29), *p* < .0001	1.19 (1.06–1.34), *p* = .0040	1.12 (0.90–1.39), *p* = .3041
Number of classes skipped (when not supposed to) in the last 4 weeks (vs. 0) (n = 26 360)			
1–5	1.43 (1.32–1.55), *p* < .0001	1.80 (1.62–1.99), *p* < .0001	2.17 (1.85–2.54), *p* < .0001
6+	1.59 (1.23–2.06), *p* = .0004	2.66 (2.00–3.55), *p* < .0001	4.77 (3.35–6.80), *p* < .0001
"Getting good grades is important to me" (vs. Strongly agree) (n = 26 239)			
Agree	1.21 (1.05–1.39), *p* = .0078	1.41 (1.17–1.69), *p* = .0003	1.78 (1.38–2.30), *p* < .0001
Disagree/strongly disagree	1.05 (0.99–1.11), *p* = .0846	1.20 (1.11–1.30), *p* < .0001	1.39 (1.21–1.59), *p* < .0001
Mark in most recent English course (vs. Less than 60%) (n = 26 021)			
60–69%	0.95 (0.83–1.09), *p* = .4795	0.93 (0.78–1.11), *p* = .4286	0.72 (0.55–0.95), *p* = .0206
70–79%	0.85 (0.76–0.95), *p* = .0060	0.77 (0.67–0.90), *p* = .0006	0.62 (0.49–0.78), *p* < .0001
80–89%	0.86 (0.77–0.96), *p* = .0079	0.85 (0.74–0.97), *p* = .0195	0.74 (0.60–0.92), *p* = .0062
90–100%	0.87 (0.78–0.98), *p* = .0164	0.82 (0.71–0.95), *p* = .0089	0.71 (0.56–0.90), *p* = .0051
Mark in most recent Math course (vs. Less than 60%) (n = 26 132)			
60–69%	0.87 (0.72–1.05), *p* = .1433	0.83 (0.65–1.06), *p* = .1335	0.65 (0.47–0.92), *p* = .0135
70–79%	0.91 (0.77–1.07), *p* = .2341	0.79 (0.64–0.97), *p* = .0224	0.51 (0.38–0.69), *p* < .0001
80–89%	0.86 (0.74–1.01), *p* = .0588	0.75 (0.61–0.91), *p* = .0041	0.53 (0.39–0.70), *p* < .0001
90–100%	0.85 (0.72–1.00), *p* = .0549	0.70 (0.56–0.87), *p* = .0014	0.47 (0.33–0.68), *p* < .0001

Abbreviations: CI, confidence interval; GEE, generalized estimating equations; RRR, relative risk ratio.

Notes: Year 1: 2012-2013, year 2: 2013-2014 and year 3: 2014-2015.

Results reflect the likelihood of students reporting the indicated response category relative to reference category when they shift from reporting "Never" binge drinking at baseline to "Rare/Sporadic", "Monthly", or "Weekly" at follow-up.

ᵃ Adjusted for gender, grade, race/ethnicity, tobacco use, and the individual mean of all time-varying covariates and the predictor.

ᵇ The varied sample size by model reflects the treatment of missing data as missing completely at random, and exclusion on analysis-by-analysis basis.

Conclusion

Results showcase the need to increase and improve prevention strategies for problematic drinking among youth, a cohort believed to have heightened vulnerability to the negative effects of substance use. These efforts should be considered a priority in educational systems, given the potential to improve student engagement and performance, and avoid the many life-long consequences associated with school failure and dropout.[12] Based on this study, the initiation and escalating frequency of binge drinking appears detrimental to student attendance, homework completion, grades, and perceived value of school achievement, which may impede students from reaching their future academic goals.

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Conflicts of interest

The authors have no conflicts of interest to report.

Authors' contributions and statement

KP led the writing of the manuscript and the study concept. WQ carried out the data analysis. All authors informed the data analysis and design, contributed to interpretation of the results, and approved the final version.

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