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Co-Use of Alcohol and Cannabis During COVID-19: Associations Between Sociodemographic Factors and Self-Reported Mental Health Symptoms and Heavy Episodic Drinking in Canadian Adults

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Abstract: This study estimates the prevalence of co-use of alcohol and cannabis, assesses the sociodemographic risk factors of co-use, and examines the associations between mental health and heavy episodic drinking (HED) and co-use of alcohol and cannabis in Canada during the early years of the COVID-19 pandemic. Nine successive cross-sectional surveys, held from May 2020 to January 2022, of adults (aged ≥18 years) living in Canada were pooled for 9,011 participants. The prevalence of co-use was calculated across sociodemographic groups. Logistic regressions were used to assess associations. Co-use of alcohol and cannabis was associated with a greater likelihood of engaging in HED and experiencing symptoms of anxiety, depression, and loneliness. The prevalence of co-use of alcohol was different across sociodemographic groups. The highest prevalence was among TGD people (35.5%), followed by individuals aged 18-39 years (14.5%). Additionally, being TGD, separated/divorced/widowed, living in an urban area, and having a high household income increased the likelihood of reporting co-use of alcohol and cannabis. These findings underscore the fact that developing public health and clinical interventions for preventing and treating excessive alcohol or cannabis use must consider both alcohol and cannabis use patterns and should be tailored to the highest-risk TGD and young adults.

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1. Introduction

Alcohol and cannabis are the two most commonly used psychoactive substances in Canada [1, 2]. The use of these substances by Canadians leads to a substantial burden of health and social harms. In particular cannabis 287 deaths in Canada in 2012 [3], and alcohol use caused 17,098 deaths in Canada in 2020 [4]. The COVID-19 pandemic and the associated social distancing policies further increased problematic alcohol and cannabis consumption in Canada [1, 2, 5]. In 2021, 18% of Canadians 15 years of age and or older reported consuming five or more drinks on days they had consumed alcohol in the previous month; this proportion was higher than what was recorded before the pandemic (11% in 2017) [1]. Also, among Canadians who had previously consumed cannabis, 34% reported increased consumption during the pandemic, compared with the pre-pandemic period [1]. Evidence suggests there is a strong association between cannabis and alcohol use [6-9]. Among alcohol users, cannabis is the most widely used substance (excluding alcohol) [10, 11]; similarly, most cannabis users report using alcohol [12]. Simultaneous use of alcohol and cannabis is considered a risk for users' safety and well-being [7, 13], mainly because of its additive effects [14-16]. The co-use of alcohol and cannabis (i.e., the use of both substances within a given period of time [10, 16]) is associated with increased risk of serious public health concerns, including unsafe driving behaviours, including heavy episodic drinking (adults in the United States were 3.7 times more likely to binge drink in the past month if they used cannabis in the past month) [16, 17], higher rates of alcohol use disorders [16, 18, 19].

Co-use of alcohol and cannabis is also associated with an increased prevalence of mental illness [16, 18]. Indeed, co-use increases the risk of behavioural problems, psychosis, and substance-related harms [20, 21]. Although the use of cannabis is associated with the development of mood disorders and anxiety disorders as well as loneliness [16, 18, 22], and the use of alcohol is causally related to the development of mood disorders and associated with loneliness [22, 23], it is currently unknown if anxiety, mood disorders or loneliness are associated with co-use of cannabis and alcohol.

Given that the co-use of alcohol and cannabis affects the health outcomes for the general population, it is imperative to understand co-users better and provide new insights that may inform interventions and prevention strategies to reduce its burden. However, despite these concerns about the additive harms of alcohol and cannabis co-use, limited research has explicitly examined the prevalence of and the sociodemographic risk factors associated with alcohol and cannabis co-use compared to the exclusive use of either substance among Canadians [24, 25]. Most studies investigating risk factors of co-use have focused on adolescents and young adults (aged 12-25), and most of this work has only examined the role of age, gender, and ethno-racial background [24]. Furthermore, results of previous studies have been mixed in terms of which sociodemographic factors affect co-use, particularly regarding gender and ethno-racial background [25-28]. A study examining co-use among adults in the US found that this behaviour was strongly associated with being younger (aged 18-49) and having less than a high school education [29]. The examination of the association between non-binary gender and polysubstance use has focused mainly on transgender and gender-diverse individuals (i.e., those whose gender identity differs from their assigned sex at birth [30]) [31]. A cross-sectional study on 32,072 students in the US, including 335 transgender and gender-diverse individuals, examined the simultaneous use of alcohol, cigarettes, cannabis or other drugs within the previous 30 days [32]. Transgender adolescents were five times more likely to engage in polysubstance use than their cisgender peers (i.e. those whose gender identity matches their assigned sex at birth [30]) [31].

The present study extends the investigation of the co-use of alcohol and cannabis using repeated cross-sectional surveys conducted in Canada during the COVID-19 pandemic to understand the harms and risk factors associated with this behaviour. The specific objectives of this study are to 1)

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estimate the prevalence of co-use of alcohol and cannabis across sociodemographic groups, including age, gender (i.e., women, men, and transgender and gender diverse people), ethno-racial background and socioeconomic status (i.e., employment status, household income, and educational attainment); 2) identify specific sociodemographic risk factors associated with co-use of alcohol and cannabis, and 3) examines the associations between mental health and heavy episodic drinking and co-use of alcohol and cannabis in Canada during the early years of the COVID-19 pandemic.

2. Material And Methods

2.1. Participants and Data Collection

Data were obtained from nine successive web-based cross-sectional surveys of English-speaking Canadian adults ≥18 years of age. The survey data were collected by the survey firm Delvinia through their web panel called Asking Canadians (http://www.delvinia.com/solutions/askingcanadians/), using a proportional quota sampling to approximate the distribution of the English-speaking Canadian population by age, sex, and region [33]. Participants completed electronic consent forms before initiating the survey, and the study received ethics approval from the Centre for Addiction and Mental Health. The surveys were conducted from May 2020 to January 2022: May 8-12 (survey 1, n=1,005, response rate (RR)=15.9%), May 29-June 1 (survey 2, n=1,002, RR=17.2%), June 19-23 (survey 3, n=1,005, RR=16.4%), July 10-14 (survey 4, n=1,003, RR=13.7%), September 18-22 (survey 5, n=1,003, RR=17.6%), November 27-December 1 (survey 6, n=1,003, RR=16.2%), March 19-23 (survey 7, n=1,000, RR=15.8%), July 9-13 (survey 8, n=1,001, RR=12.5%), and January 7-11, 2022 (survey 9, n=1,004, RR=10.3%). Table S1 of the supplement contains the details of RR calculations and the survey interview information. A pooled sample of 9,011 participants was analyzed in this study.

2.2. Measures

Co-use of alcohol and cannabis was measured by combining the responses to two distinct questions on substance use. (1) "During the past seven days, on how many days did you use alcohol?" and (2) "During the past seven days, on how many days did you use cannabis?". Response categories for each question were recoded to reflect use on at least one day (coded 1) versus use on 0 days (coded 0). Participants who reported using alcohol on at least one day and who also reported using cannabis on at least one day were classified as engaging in alcohol and cannabis co-use in the past week. The co-use binary variable, which reflects the use of alcohol and cannabis, was coded 1 if they used both substances at least once in the past week and 0 otherwise.

Anxiety was measured by the Generalized Anxiety Disorder (GAD-7) scale [34]. The GAD-7 includes seven items using a four-point metric, ranging from 0 = "not at all" to 3= "nearly every day." The total score ranged from 0 to 21, with higher scores reflecting more severe functional impairments because of anxiety. Participants with a score ≥ 10 were defined as experiencing moderate to severe anxiety [35-38].

Depression was measured by a single question from the Center for Epidemiologic Studies Depression Scale (CES-D) [39]: "In the past 7 days, how often have you felt depressed?" Response categories were "rarely or none of the time (less than 1 day)", "some or a little of the time (1-2 days)", "occasionally or a moderate amount of the time (3-4 days)", and "most or all of the time (5-7 days)". Those who reported feeling depressed 3-4 or 5-7 days were identified as experiencing depressive symptoms [39].

Loneliness was measured with a single item from the CES-D [39]. This item asked participants, "In the past 7 days, how often have you felt lonely?" with the following response options: "rarely or none of the time (less than 1 day)", "some or a little of the time (1-2 days)", "occasionally or a moderate amount of the time (3-4 days)", and "most or all of the time (5-7 days)" [39]. Participants were considered lonely if they reported feeling lonely for 3-4 or 5-7 days.

Heavy episodic drinking (HED) was assessed using the question: "On how many of the past seven days did you drink five/four or more drinks on one occasion?" Heavy episodic drinkers were defined

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as the consumption of 5 or more standard drinks (≥68.0 grams of alcohol) for cisgender men and transgender and gender diverse (TGD) participants and 4 or more standard drinks (≥54.4 grams of alcohol) for cisgender women [40, 41].

2.3. Covariates

Sociodemographic covariates included gender (cisgender men, cisgender women, and TGD), age (18-39, 40-59 and 60+ years), ethno-racial background (White and Non-white (i.e., Asian/Black/Indigenous/Arab/Latinx and other ethnicities)), marital status (married/living with a partner, separated/divorced/widowed, single and marital status not stated), and residential environment (urban, suburban, and rural). Note that the gender identity question had the following response options: "Man," "Woman," "Transgender man," "Transgender woman," "Two-Spirit," "Non-binary (genderqueer, gender fluid)," "Questioning/Not sure of my gender identity," "Identity not listed," and "Prefer not to answer." Individuals who self-identified as transgender, two-spirit, or non-binary and those who selected "Questioning/Not sure of my gender identity" or did not find their gender listed were categorized as TGD. We excluded participants who responded "prefer not to answer" from the main analysis (i.e., 21 participants).

Additional covariates included socioeconomic status measured by household income (less than $40,000 as the reference category, $40,000-$79,999, $80,000-$119,999, $120,000 or more, and income not stated)), educational attainment (post-secondary as the reference category, high school diploma or less, college degree/diploma, university degree/diploma, and education attainment not stated), and employment status during COVID-19 (employed (no change due to the pandemic) as the reference category, unemployed (no change due to the pandemic), and other impacts on employment (i.e., participants working from home due to the pandemic and returning to their usual workplace or participants who were unemployed/laid off/let go due to the pandemic who were back working with the same or a new employer)).

2.4. Statistical Analyses

We calculated the prevalence of the use of alcohol only, cannabis only, co-use and no-use of both substances by sociodemographic characteristics. We also performed multivariate logistic regressions on the pooled data from May 2020 to January 2022 to assess (i) the sociodemographic risk factors for co-use of alcohol and cannabis, and (ii) associations of mental health symptoms and HED with co-use during the pandemic. To assess the risk factors, four multivariate logistic regressions were used to compare co-use of alcohol and cannabis to 1) non-co-use of both substances, 2) use of alcohol only (i.e., use of alcohol and non-use of cannabis), 3) use of cannabis only (i.e., use of cannabis and non-use of alcohol), and 3) no-use of both substances. Adjusted odds ratios (aORs) and 95% confidence intervals (CIs) were presented for each regression. Stata version 16.1 (StataCorp, College Station, Texas 77845 USA) was used for all analyses.

3. Results

3.1. Description of Participants and Prevalence of Co-Use of Alcohol and Cannabis

Table 1 shows study respondents' sociodemographic characteristics and substance use prevalence across socio-demographic groups. Most of the 9,011 participants were White (68.9%), married (62.5%), employed (85.0%), and had a university degree (52.2%). Approximately 48% of participants reported drinking alcohol only (without cannabis); 3.1% used only cannabis, and 10.1% used alcohol and cannabis during the past week. The prevalence of co-use was higher among individuals aged 18–39 years (14.5%), unemployed individuals (13.3%), individuals with a high household income of $80,000-$119,000 (12.8%), higher among TGD people (35.5%) followed by cisgender men (11.9%), individuals living in an urban area (11.0%), and individuals with less than a university degree (10.5-11.9%).

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Table 1. Sociodemographic characteristics of respondents and prevalence of alcohol, cannabis, and co-use across socio-demographic groups.

	Total sample		Alcohol Only (n=4,353)	Cannabis only (n=280)	Co-use (n=907)	No-use (n=3,471)
	n	%	%	%	%	%
Total, n (%)	9,011	100	48.3	3.1	10.1	38.5
Gender						
Man	4,456	49.5	50.4	3.1	11.9	34.6
Woman	4,472	49.6	46.7	3.1	8.0	42.3
Transgender and gender-diverse	62	0.7	24.2	6.4	35.5	33.9
Prefer not to answer	21	0.2	19.1	0	0	80.9
Age						
Age 18-39	3,467	38.5	41.3	4.7	14.5	39.5
Age 40-59	2,846	31.6	48.4	2.9	9.3	39.5
Age 60+	2,698	29.9	57.2	1.3	5.3	36.2
Ethno-racial background						
White	6,209	68.9	53.8	3.2	10.0	33.1
Non-white	2,802	31.1	36.2	3.0	10.3	50.6
Marital status						
Separated/divorced/widowed	1,126	12.5	45.9	2.7	9.9	41.6
Married	5,631	62.5	52.4	2.6	9.8	35.2
Single	2,135	23.7	39.4	4.7	10.9	45.0
Marital status not stated	119	1.3	35.3	2.5	10.9	51.3
Residential environment						
Urban	4,224	46.9	46.3	3.2	11.0	39.5
Suburban	3,356	37.2	51.1	2.8	9.5	36.7
Rural	1,431	15.9	47.8	3.7	8.6	39.9
Income						
Inc_less40k	1,080	12	32.0	4.7	10.0	53.2
Income of $40,000-$79,999	2,216	24.6	44.2	4.1	11.5	40.2
Income of $80,000-$119,999	2,031	22.5	50.5	2.7	12.8	34.0
Income $120,000+	2,238	24.8	57.2	2.0	9.8	31.0
Income not stated	1,446	16	49.9	2.6	4.6	42.9
Employment situation during COVID-19						
Employed	7,660	85.0	49.1	3.0	9.6	38.2
Unemployed	867	9.62	44.3	4.4	13.3	38.1
Other impact on employment	484	5.37	42.4	2.7	11.4	43.6
Educational attainment						
Post-secondary	1,362	15.1	44.8	4.3	11.4	39.6
High school	1,068	11.9	41.2	4.5	10.5	43.8
College	1,802	20	46.6	3.9	11.9	37.6
University	4,703	52.2	51.8	2.2	8.9	37.1
Education attainment not stated	76	0.8	32.9	1.3	7.9	57.9

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3.2. Associations of Sociodemographic Factors with Co-Use of Alcohol and Cannabis

Table 2 shows the results of logistic regressions between sociodemographic characteristics and co-use of alcohol and cannabis. Comparing co-use and non-co-use, TGD people (aOR=3.61, 95% CI 2.09 - 6.25), people who were separated/divorced/widowed (aOR=1.60, 95% CI 1.23 - 2.07), people living in urban areas (aOR=1.26, 95% CI 1.07 - 1.56), and people with a high household income of $80,000-$119,000 (aOR=1.41, 95% CI 1.09 - 1.82) were at greater odds of reporting co-use of alcohol and cannabis during the pandemic compared to men, single individuals, people living in rural areas, and those with income less than $40,000., respectively. However, women (aOR=0.63, 95%CI 0.55 - 0.73), people aged 40-59 years (aOR=0.53, 95% CI 0.45 - 0.63) and 60+ (aOR=0.27, 95% CI 0.22 - 0.33), and non-White people (i.e., Asian/Black/Indigenous/Arab/Latinx and other ethnicities) (aOR=0.77, 95% CI 0.66 - 0.91), unemployed individuals (aOR=0.74, 95%CI 0.59 - 0.92) and those with university degree (aOR=0.67, 95%CI 0.54 - 0.82) were at lower odds of reporting the co-use of alcohol and cannabis during the pandemic compared to men, younger adults, white people, employed individuals, and people with high school diploma, respectively. These results are generally qualitatively similar to those obtained when the co-users group was compared to the alcohol only users, cannabis only users and non-users groups.

Table 2. Associations of sociodemographic factors with the co-use of alcohol and cannabis during the pandemic.

	Co-use vs. non co-use	**Co-use vs. alcohol use only**	**Co-use vs. cannabis use only**	**Co-use vs. no-use**
	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Gender				
Men (ref.)				
Women	0.63*** (0.55-0.73)	0.71*** (0.61-0.83)	0.74** (0.55-0.99)	0.54*** (0.46-0.63)
TGD	3.61*** (2.09-6.25)	4.73*** (2.36-9.49)	1.72 (0.56-5.27)	3.42*** (1.81-6.46)
Age				
Age 18-39 (ref.)				
Age 40-59	0.53*** (0.45-0.63)	0.51*** (0.42-0.61)	1.1 (0.79-1.52)	0.54*** (0.45-0.65)
Age 60 +	0.27*** (0.22-0.33)	0.23*** (0.18-0.29)	1.44 (0.91-2.28)	0.30*** (0.24-0.37)
Ethno-racial background				
White (ref.)				
Non-White	0.77*** (0.66-0.91)	1.1 (0.92-1.3)	1.07 (0.78-1.47)	0.48*** (0.41-0.58)
Marital status				
Single (ref.)				
Separated/divorced/widowed	1.60*** (1.23-2.07)	1.46*** (1.1-1.94)	1.77** (1.07-2.95)	1.59*** (1.2-2.11)
Married	1.19 (1-1.42)	1.08 (0.89-1.31)	1.44** (1.04-1.99)	1.34*** (1.11-1.62)
Marital status not stated	1.85 (0.96-3.57)	2.25** (1.07-4.74)	2.21 (0.54-9.09)	1.87 (0.91-3.84)
Living area				
Rural (ref.)				
Urban	1.26** (1.01-1.56)	1.11 (0.88-1.4)	1.37 (0.91-2.06)	1.40*** (1.11-1.78)
Suburban	1.07 (0.85-1.34)	0.92 (0.72-1.17)	1.38 (0.91-2.1)	1.21 (0.95-1.55)
Income				

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Income: less than $40,000 (ref.)				
Income: $40,000-$79,999	1.24 (0.97-1.59)	0.91 (0.69-1.2)	1.32 (0.86-2.03)	1.51*** (1.17-1.96)
Income: $80,000-$119,999	1.41*** (1.09-1.82)	0.93 (0.7-1.23)	2.06*** (1.28-3.32)	1.89*** (1.44-2.48)
Income: $120,000+	1.06 (0.81-1.38)	0.65*** (0.48-0.87)	2.01*** (1.2-3.37)	1.59*** (1.2-2.12)
Income not stated	0.51*** (0.36-0.71)	0.35*** (0.25-0.51)	0.78 (0.45-1.35)	0.64** (0.45-0.9)
Employment				
Employed (ref.)				
Unemployed	0.74*** (0.59-0.92)	0.79** (0.62-1)	0.96 (0.63-1.46)	0.69*** (0.54-0.88)
Other impacts on employment	1.04 (0.73-1.49)	1.15 (0.78-1.7)	1.46 (0.7-3.03)	0.9 (0.61-1.33)
Educational attainment				
Post-secondary (ref.)				
High school	0.96 (0.73-1.25)	1 (0.75-1.33)	0.95 (0.59-1.53)	0.89 (0.67-1.18)
College	1.01 (0.81-1.27)	0.97 (0.76-1.24)	1.19 (0.78-1.81)	1.06 (0.83-1.36)
University	0.67*** (0.54-0.82)	0.58*** (0.46-0.72)	1.48 (1-2.2)	0.75** (0.6-0.95)
Education attainment not stated	0.85 (0.33-2.17)	0.84 (0.3-2.36)	2.73 (0.27-27.93)	0.77 (0.28-2.1)
Survey waves				
Wave 1 (ref.)				
Wave 2	1.14 (0.84-1.56)	1.07 (0.77-1.49)	1.02 (0.56-1.87)	1.26 (0.9-1.76)
Wave 3	1.27 (0.93-1.72)	1.2 (0.86-1.65)	1.74 (0.9-3.35)	1.37 (0.98-1.91)
Wave 4	1.28 (0.94-1.74)	1.18 (0.85-1.63)	1.25 (0.67-2.31)	1.43** (1.02-1.99)
Wave 5	1.17 (0.85-1.6)	1.19 (0.85-1.67)	1.36 (0.72-2.56)	1.11 (0.79-1.56)
Wave 6	1.43** (1.06-1.93)	1.48** (1.07-2.04)	0.82 (0.46-1.44)	1.44** (1.04-2)
Wave 7	1.31 (0.97-1.78)	1.38 (0.99-1.91)	1.06 (0.58-1.94)	1.32 (0.95-1.84)
Wave 8	1.09 (0.8-1.5)	1.05 (0.75-1.46)	1.01 (0.55-1.87)	1.2 (0.86-1.69)
Wave 9	1.32 (0.97-1.8)	1.29 (0.93-1.79)	0.82 (0.46-1.47)	1.43** (1.02-1.99)
Constant	0.21*** (0.14-0.33)	0.65 (0.41-1.03)	1.03 (0.46-2.31)	0.39*** (0.25-0.63)
Observations	8,990	5,256	1,187	4,361
Pseudo R-squared	0.0603	0.0846	0.0516	0.0824

Legend: *** and ** Odds ratios are significant at the 1% and 5% significance level, respectively. 95% confidence intervals in parentheses. ref: reference category

3.3. Associations with Heavy Episodic Drinking, Anxiety, Depression, and Loneliness

Table 3 shows the results of multivariate logistic regressions of co-use on self-reported: anxiety, depression, loneliness, and HED (controlling for sociodemographic characteristics). Co-use of alcohol and cannabis (vs. non co-use) was strongly associated with self-reported HED (aOR=7.58, 95% CI 6.50 - 8.84), anxiety (aOR=1.93, 95% CI 1.65 - 2.25), depression (aOR=1.96, 95% CI 1.67 - 2.29), and loneliness (aOR=1.87, 95% CI 1.60 - 2.19). Being a woman, TGD, and unemployed increased the likelihood of reporting anxiety, depression, and loneliness. Those who were separated/divorced/widowed, had a household income higher than $40,000, and unemployed were more likely to report heavy alcohol drinking.

Table 3. Associations of co-use of alcohol with heavy episodic drinking and mental health symptoms.

	Anxiety	**Depression**	**Loneliness**	**Heavy episodic drinking**
Non co-use (Ref)				

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Co-use of alcohol and cannabis	1.93*** (1.65 - 2.25)	1.96*** (1.67 - 2.29)	1.87*** (1.60 - 2.19)	7.58*** (6.50 - 8.84)
Gender				
Men (ref.)				
Women	1.42*** (1.28 - 1.59)	1.37*** (1.23 - 1.53)	1.34*** (1.20 - 1.49)	0.78*** (0.70 - 0.87)
Transgender and gender-diverse	2.06*** (1.21 - 3.50)	2.72*** (1.61 - 4.60)	2.31*** (1.37 - 3.92)	0.87 (0.48 - 1.59)
Age				
Age 18-39 (ref.)				
Age 40-59	0.78*** (0.69 - 0.88)	1.00 (0.88 - 1.13)	0.83*** (0.74 - 0.95)	1.03 (0.91 - 1.17)
Age 60 +	0.34*** (0.29 - 0.40)	0.45*** (0.39 - 0.53)	0.45*** (0.39 - 0.53)	0.71*** (0.61 - 0.82)
Ethno-racial background				
White (ref.)				
Non White	1.15** (1.02 - 1.29)	1.01 (0.89 - 1.13)	1.04 (0.92 - 1.17)	0.93 (0.83 - 1.05)
Marital status				
Single (ref.)				
Separated/divorced/widowed	1.12 (0.92 - 1.36)	1.07 (0.89 - 1.29)	1.21** (1.01 - 1.44)	1.22** (1.01 - 1.48)
Married	1.04 (0.91 - 1.18)	0.86** (0.75 - 0.97)	0.50*** (0.44 - 0.56)	1.07 (0.94 - 1.22)
Living area				
Rural (ref.)				
Urban	1.13 (0.96 - 1.33)	1.12 (0.95 - 1.32)	1.02 (0.87 - 1.19)	0.96 (0.83 - 1.12)
Suburban	1.07 (0.91 - 1.26)	1.03 (0.87 - 1.22)	0.94 (0.80 - 1.11)	1.01 (0.87 - 1.18)
Income				
Income: less than $40,000 (ref.)				
Income: $40,000-$79,999	0.77*** (0.64 - 0.91)	0.68*** (0.58 - 0.81)	0.74*** (0.62 - 0.87)	1.36*** (1.13 - 1.63)
Income: $80,000-$119,999	0.63*** (0.52 - 0.76)	0.56*** (0.46 - 0.67)	0.75*** (0.62 - 0.89)	1.34*** (1.10 - 1.62)
Income: $120,000+	0.57*** (0.47 - 0.69)	0.42*** (0.34 - 0.51)	0.51*** (0.42 - 0.62)	1.53*** (1.25 - 1.86)
Income not stated	0.57*** (0.47 - 0.70)	0.58*** (0.47 - 0.70)	0.58*** (0.48 - 0.71)	1.01 (0.82 - 1.25)
Employment				
Employed (ref.)				
Unemployed	1.81*** (1.55 - 2.13)	1.74*** (1.48 - 2.05)	1.68*** (1.43 - 1.97)	1.31*** (1.11 - 1.55)
Other impacts on employment	1.24 (0.99 - 1.55)	1.23 (0.98 - 1.55)	1.21 (0.96 - 1.51)	1.05 (0.84 - 1.32)
Educational attainment				
High school (ref.)				
Post-secondary	1.29** (1.05 - 1.58)	1.21 (0.99 - 1.48)	1.06 (0.87 - 1.29)	0.97 (0.80 - 1.18)
College	1.14 (0.94 - 1.38)	1.02 (0.84 - 1.24)	0.94 (0.78 - 1.13)	0.96 (0.80 - 1.16)
University	1.10	1.04	0.97	0.89

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	(0.92 - 1.31)	(0.87 - 1.23)	(0.82 - 1.14)	(0.75 - 1.05)
Wave 2	0.81	1.08	1.05	1.03
	(0.66 - 1.01)	(0.87 - 1.36)	(0.85 - 1.31)	(0.83 - 1.28)
Wave 3	0.72***	0.90	0.90	1.15
	(0.58 - 0.89)	(0.72 - 1.13)	(0.72 - 1.12)	(0.93 - 1.43)
Wave 4	0.72***	0.95	1.06	1.19
	(0.58 - 0.90)	(0.75 - 1.19)	(0.85 - 1.32)	(0.96 - 1.47)
Wave 5	0.84	1.14	0.90	1.13
	(0.67 - 1.04)	(0.91 - 1.43)	(0.72 - 1.13)	(0.91 - 1.40)
Wave 6	0.99	1.16	1.09	1.06
	(0.80 - 1.22)	(0.93 - 1.45)	(0.88 - 1.36)	(0.86 - 1.32)
Wave 7	0.82	1.05	0.95	1.07
	(0.66 - 1.01)	(0.84 - 1.31)	(0.76 - 1.18)	(0.86 - 1.33)
Wave 8	0.73***	0.95	0.80*	1.19
	(0.58 - 0.91)	(0.76 - 1.20)	(0.64 - 1.00)	(0.96 - 1.48)
Wave 9	1.04	1.20	1.14	1.04
	(0.84 - 1.28)	(0.96 - 1.49)	(0.91 - 1.41)	(0.83 - 1.29)
Constant	0.36***	0.34***	0.59***	0.23***
	(0.27 - 0.49)	(0.25 - 0.46)	(0.45 - 0.79)	(0.17 - 0.32)
Observations	8,990	8,990	8,990	8,976
Pseudo R-squared	0.0625	0.0565	0.0768	0.0922

Legend: *** and ** Odds ratios are significant at the 1% and 5% significance level, respectively. 95% confidence intervals in parentheses. Ref.: reference category.

4. Discussion

The present study aimed to assess the prevalence of co-use of alcohol and cannabis during the pandemic across sociodemographic groups and identify risk factors of co-use in Canadian adults. We also examined the associations of co-use of these substances with mental health symptoms and HED.

4.1. Prevalence and Sociodemographic Risk Factors of Co-Use of Alcohol and Cannabis

We found that the prevalence of co-use of alcohol and cannabis during the pandemic varied across sociodemographic characteristics – it was notably higher among TGD people and cisgender men, people aged 18–39 years, unemployed people, individuals living in urban areas, and those with high household income ($80,000-$119,000). Additionally, the multivariate logistic regression results revealed that TGD people (vs cisgender men), people living in urban areas (vs rural areas), people who were separated/divorced/widowed (vs single), and people with high household income (vs less than $40,000) were more likely to report co-use of alcohol and cannabis in the past week. In addition, we found that co-users of alcohol and cannabis were more likely to report anxiety, depression, loneliness and heavy episodic drinking.

The high prevalence of co-use of substances among TGD participants compared to cisgender participants (almost 3 times higher relative to cisgender men and more than 4 times higher relative to cisgender women) is in line with the literature on substance use among TGD people. Previous studies have indicated that TGD people have high rates of alcohol use, cannabis use, illicit drug use, and non-medical use of prescription drugs compared with cisgender people [32, 42-45]. Other research has indicated that TGD people were also more likely than cisgender men to co-use alcohol and cannabis during the COVID-19 pandemic, potentially due to increased psychological distress [46, 47].

Our findings replicate previous results showing that the odds of co-use are higher among cisgender men and those of a younger age group [17, 29, 48, 49]. For example, studies on college-aged drinkers in the US showed that the use of cannabis increased with the level of alcohol consumption [50, 51]. We also identified several protective factors for co-using alcohol and cannabis that were

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found in some studies: women, non-White (i.e., Asian/Black/Indigenous/Arab/Latinx and other ethnicities), and unemployed [27, 28, 52]. Other socio-demographic correlates of co-use of alcohol and cannabis, such as being separated/divorced/widowed, found in this study, were also identified in the literature [29, 53-55].

4.2. Co-Use Associations with HED, Anxiety, Depression and Loneliness

The relationship between the co-use of alcohol and cannabis and HED, anxiety, and depression is consistent with the literature as well [16, 20, 29, 48]. Co-users were at over 7 times greater odds of engaging in HED than those who did not co-use both substances. This result is in line with the findings from a large-scale longitudinal survey data from the US that found that most co-users of alcohol and cannabis were more likely to report heightened HED behaviour and depression [10, 19, 29]. This suggests that co-users might experience more problems from drinking during the pandemic, such as alcohol dependence and negative alcohol-related consequences like risky driving and mental health problems [29, 56]. These results, coupled with the fact that the odds of co-use of alcohol and cannabis are higher in younger adults and the TGD population, reflect a clinical population in which younger and TGD people may need treatment for both substances.

We also found that co-users of alcohol and cannabis are more likely to report loneliness. A similar result was found in the literature during and after the pandemic [22, 57], suggesting that alcohol and cannabis may be used together to cope following a traumatic event, such as the COVID-19 pandemic and the public health restrictions, by vulnerable individuals [58]. These associations are concerning because loneliness has increased among the general population during the pandemic, and evidence suggests that loneliness is associated with poor physical and mental health outcomes, including lower quality of life, increased suicidality, and increased substance use severity [57, 59]. This shows that interventions to reduce loneliness may help improve population health and well-being and prevent or reduce alcohol and cannabis co-use.

4.3. Limitations

There are limitations to this study. First, the use of a survey panel and reliance on participants from the English-speaking population (thus excluding French-speaking Canadians) may lead to participation and selection biases [60]. Therefore, results may not be generalizable to the entire Canadian population. Second, the measurement of gender identity in this survey may have impacted the number of TGD respondents. The gender identity question response items may not encompass all gender identities. Experts recommend adding a second question on sex assigned at birth (i.e., “male” or “female”) [61, 62] to correctly identify and classify TGD individuals, which was not done in this study. This may result in misclassification regarding gender identity. Misclassification may also occur when participants who selected: “Questioning/Not sure of my gender identity” and “Identity not listed” were included in the TGD group. Additionally, we had to group various gender identities into TGD due to small sample sizes, thus potential differences in co-use among various TGD groups could not be examined. Third, the study is cross-sectional. Thus, causal inferences and issues of temporality cannot be made. Finally, all data in this study are based on self-reported responses, which may suffer from recall bias [63, 64].

5. Conclusions

Around 10% of participants co-used alcohol and cannabis, with individuals who were TGD and young adults being significantly more likely to co-use alcohol and cannabis. Additionally, co-using cannabis and alcohol increased the likelihood of self-reported HED, anxiety, depression and loneliness, which may lead to mental health and/or alcohol use disorders [16]. These findings support the need for programs to prevent and treat both alcohol and cannabis use problems, rather than focus on a single behaviour, particularly in vulnerable populations identified, i.e., TGD, and young adult populations.

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References

1. Statistics Canada. *Alcohol and cannabis use during the pandemic: Canadian Perspectives Survey Series 6*. 2021 [cited 2022 July 16, 2022]; Available from: https://www150.statcan.gc.ca/n1/daily-quotidien/210304/dq210304a-eng.pdf.
2. Michelle, R., *Canadians who report lower self-perceived mental health during the COVID-19 pandemic more likely to report increased use of cannabis, alcohol and tobacco*, in *StatCan COVID-19: Data to Insights for a Better Canada*, S. Canada, Editor. 2020: Ottawa.
3. Imtiaz, S., et al., *The burden of disease attributable to cannabis use in Canada in 2012.* Addiction, 2016. **111**(4): p. 653–662.
4. Canadian Substance Use Costs and Harms, *Canadian Substance Use Costs and Harms (2015–2017)*. 2020, Canadian Substance Use Costs and Harms: Ottawa, Canada.
5. Bartel, S.J., S.B. Sherry, and S.H. Stewart, *Pandemic-Related Changes in Alcohol and Cannabis Use: Comparing Retrospective Reports and Prospective Data.* Int J Ment Health Addict, 2021: p. 1–7.
6. Patrick, M.E., et al., *Alcohol use and the COVID-19 pandemic: Historical trends in drinking, contexts, and reasons for use among U.S. adults.* Social Science & Medicine, 2022. **301**: p. 114887.
7. Patrick, M.E., et al., *Patterns of simultaneous and concurrent alcohol and marijuana use among adolescents.* The American Journal of Drug and Alcohol Abuse, 2018. **44**(4): p. 441–451.
8. Leatherdale, S.T. and R. Burkhalter, *The substance use profile of Canadian youth: Exploring the prevalence of alcohol, drug and tobacco use by gender and grade.* Addictive Behaviors, 2012. **37**(3): p. 318–322.
9. Metrik, J., et al., *Daily Patterns of Marijuana and Alcohol Co-Use Among Individuals with Alcohol and Cannabis Use Disorders.* Alcoholism: Clinical and Experimental Research, 2018. **42**(6): p. 1096–1104.
10. Subbaraman, M.S. and W.C. Kerr, *Simultaneous versus concurrent use of alcohol and cannabis in the National Alcohol Survey.* Alcohol Clin Exp Res, 2015. **39**(5): p. 872–9.
11. Abuse, S., *Mental Health Services Administration, Results from the 2013 National Survey on Drug Use and Health: Summary of National Findings, NSDUH Series H-48, HHS Publication No.(SMA) 14-4863.* Rockville, MD: Substance Abuse and Mental Health Services Administration, 2014. **2014**.
12. Roche, D.J.O., et al., *Alcohol, tobacco, and marijuana consumption is associated with increased odds of same-day substance co- and tri-use.* Drug Alcohol Depend, 2019. **200**: p. 40–49.
13. Schensul, J.J., M. Convey, and G. Burkholder, *Challenges in measuring concurrency, agency and intentionality in polydrug research.* Addictive Behaviors, 2005. **30**(3): p. 571–574.
14. Chait, L.D. and J.L. Perry, *Acute and residual effects of alcohol and marijuana, alone and in combination, on mood and performance.* Psychopharmacology (Berl), 1994. **115**(3): p. 340–9.
15. Ramaekers, J.G., H.W.J. Robbe, and J.F. O'Hanlon, *Marijuana, alcohol and actual driving performance.* Human Psychopharmacology: Clinical and Experimental, 2000. **15**(7): p. 551–558.
16. Yurasek, A.M., E.R. Aston, and J. Metrik, *Co-use of Alcohol and Cannabis: A Review.* Curr Addict Rep, 2017. **4**(2): p. 184–193.
17. Kepner, W.E., et al., *Past-month binge drinking and cannabis use among middle-aged and older adults in the United States, 2015–2019.* Alcohol, 2023. **107**: p. 32–37.
18. Center for Behavioral Health Statistics and Quality, *Key substance use and mental health indicators in the United States: Results from the 2015 National Survey on Drug Use and Health*, in *(HHS Publication No. SMA 16-4984, NSDUH Series H-51)*. 2016.
19. Terry-McElrath, Y.M., P.M. O'Malley, and L.D. Johnston, *Alcohol and Marijuana Use Patterns Associated With Unsafe Driving Among U.S. High School Seniors: High Use Frequency, Concurrent Use, and Simultaneous Use.* Journal of Studies on Alcohol and Drugs, 2014. **75**(3): p. 378–389.
20. Thompson, K., et al., *Co-Use of Alcohol and Cannabis: Longitudinal Associations with Mental Health Outcomes in Young Adulthood.* Int J Environ Res Public Health, 2021. **18**(7).
21. Sokolovsky, A.W., et al., *Alcohol and marijuana co-use: Consequences, subjective intoxication, and the operationalization of simultaneous use.* Drug Alcohol Depend, 2020. **212**: p. 107986.

 doi:10.20944/preprints202505.0986.v1

22. Gutkind, S., L.R. Gorfinkel, and D.S. Hasin, *Prospective effects of loneliness on frequency of alcohol and marijuana use.* Addictive behaviors, 2022. **124**: p. 107115.
23. Boden, J.M. and D.M. Fergusson, *Alcohol and depression.* Addiction, 2011. **106**(5): p. 906–914.
24. Ontario Agency for Health Protection and Promotion (Public Health Ontario), W. Meyer, and P. Leece, *Evidence brief: risk factors for simultaneous use of alcohol and cannabis.* Toronto, ON: Queen's Printer for Ontario, 2018.
25. Brière, F.N., et al., *Predictors and consequences of simultaneous alcohol and cannabis use in adolescents.* Addictive Behaviors, 2011. **36**(7): p. 785–788.
26. McCabe, S.E., et al., *Simultaneous and Concurrent Polydrug Use of Alcohol and Prescription Drugs: Prevalence, Correlates, and Consequences.* Journal of Studies on Alcohol, 2006. **67**(4): p. 529–537.
27. Terry-McElrath, Y.M., P.M. O'Malley, and L.D. Johnston, *Simultaneous alcohol and marijuana use among U.S. high school seniors from 1976 to 2011: trends, reasons, and situations.* Drug Alcohol Depend, 2013. **133**(1): p. 71–9.
28. Collins, R.L., P.L. Ellickson, and R.M. Bell, *Simultaneous polydrug use among teens: prevalence and predictors.* J Subst Abuse, 1998. **10**(3): p. 233–53.
29. Midanik, L.T., T.W. Tam, and C. Weisner, *Concurrent and simultaneous drug and alcohol use: results of the 2000 National Alcohol Survey.* Drug Alcohol Depend, 2007. **90**(1): p. 72–80.
30. Baker, K.E., *The Future of Transgender Coverage.* N Engl J Med, 2017. **376**(19): p. 1801–1804.
31. Goodwin, S.R., et al., *A Scoping Review of Gender, Sex and Sexuality Differences in Polysubstance Use in Adolescents and Adults.* Alcohol and Alcoholism, 2022. **57**(3): p. 292–321.
32. Day, J.K., et al., *Transgender Youth Substance Use Disparities: Results From a Population-Based Sample.* Journal of Adolescent Health, 2017. **61**(6): p. 729–735.
33. Callegaro, M. and C. DiSogra, *Computing Response Metrics for Online Panels.* Public Opinion Quarterly, 2008. **72**(5): p. 1008–1032.
34. Spitzer, R.L., et al., *A Brief Measure for Assessing Generalized Anxiety Disorder: The GAD-7.* Archives of Internal Medicine, 2006. **166**(10): p. 1092–1097.
35. Roy-Byrne, P., et al., *Brief intervention for anxiety in primary care patients.* Journal of the American Board of Family Medicine : JABFM, 2009. **22**(2): p. 175–186.
36. Ren, Z., Y. Zhou, and Y. Liu, *The psychological burden experienced by Chinese citizens during the COVID-19 outbreak: prevalence and determinants.* BMC Public Health, 2020. **20**(1): p. 1617.
37. Kroenke, K., et al., *The Patient Health Questionnaire Somatic, Anxiety, and Depressive Symptom Scales: a systematic review.* General Hospital Psychiatry, 2010. **32**(4): p. 345–359.
38. Elton-Marshall, T., et al., *Multiple COVID-19 Risk Factors Increase the Likelihood of Experiencing Anxiety Symptoms in Canada.* The Canadian Journal of Psychiatry, 2020: p. 0706743720949356.
39. Radloff, L.S., *The CES-D Scale:A Self-Report Depression Scale for Research in the General Population.* Applied Psychological Measurement, 1977. **1**(3): p. 385–401.
40. Somé, N.H., et al., *Alcohol and cannabis use during the COVID-19 pandemic among transgender, gender-diverse, and cisgender adults in Canada.* (1471-2458 (Electronic)).
41. Flentje, A., et al., *Screening gender minority people for harmful alcohol use.* PloS one, 2020. **15**(4): p. e0231022–e0231022.
42. Benotsch, E.G., et al., *Non-medical use of prescription drugs, polysubstance use, and mental health in transgender adults.* Drug Alcohol Depend, 2013. **132**(1-2): p. 391–4.
43. Santos, G.M., et al., *Alcohol and substance use among transgender women in San Francisco: prevalence and association with human immunodeficiency virus infection.* Drug Alcohol Rev, 2014. **33**(3): p. 287–95.
44. Hughto, J.M.W., et al., *Prevalence and Co-occurrence of Alcohol, Nicotine, and Other Substance Use Disorder Diagnoses Among US Transgender and Cisgender Adults.* JAMA Network Open, 2021. **4**(2): p. e2036512–e2036512.
45. Connolly, D. and G. Gilchrist, *Prevalence and correlates of substance use among transgender adults: A systematic review.* Addictive Behaviors, 2020. **111**: p. 106544.
46. Kidd, J.D., et al., *Understanding the Impact of the COVID-19 Pandemic on the Mental Health of Transgender and Gender Nonbinary Individuals Engaged in a Longitudinal Cohort Study.* J Homosex, 2021. **68**(4): p. 592–611.
47. Restar, A.J., et al., *Characterising the impact of COVID-19 environment on mental health, gender affirming services and socioeconomic loss in a global sample of transgender and non-binary people: a structural equation modelling.* BMJ Glob Health, 2021. **6**(3).
48. Tucker, J.S., et al., *Alcohol and cannabis co-use in a national sample of U.S. adults ages 30-80.* Addictive Behaviors, 2023. **142**: p. 107663.
49. Höhne, B., et al., *Patterns of concurrent alcohol, tobacco, and cannabis use in Germany: Prevalence and correlates.* Drugs: Education, Prevention and Policy, 2014. **21**(2): p. 102–109.
50. O'Grady, K.E., et al., *Heavy Drinking and Polydrug Use among College Students.* J Drug Issues, 2008. **38**(2): p. 445–466.
51. Jones, S.E., et al., *Binge drinking among undergraduate college students in the United States: implications for other substance use.* J Am Coll Health, 2001. **50**(1): p. 33–8.

 doi:10.20944/preprints202505.0986.v1

52. Neddermann-Carrillo, S., et al., *Tobacco and alcohol co-use: Lifestyle and sociodemographic factors, and personality aspects as potential predictors in the "Seguimiento Universidad de Navarra" cohort.* Research in Nursing & Health, 2024. **47**(2): p. 251–265.
53. Higgins, S.T., et al., *Alcohol dependence and simultaneous cocaine and alcohol use in cocaine-dependent patients.* J Addict Dis, 1994. **13**(4): p. 177–89.
54. Ogborne, A.C., B.M. Kapur, and B. Newton-Taylor, *Characteristics of drug users admitted to alcohol detoxication centers.* Am J Drug Alcohol Abuse, 1992. **18**(2): p. 177–86.
55. Airagnes, G., et al., *Alcohol, tobacco and cannabis use are associated with job loss at follow-up: Findings from the CONSTANCES cohort.* PLoS One, 2019. **14**(9): p. e0222361.
56. Linden-Carmichael, A.N., et al., *Are Co-users of Alcohol and Marijuana More Willing to Experience Consequences From Drinking? A Longitudinal Examination Among First-Year College Students.* Alcohol Clin Exp Res, 2019. **43**(7): p. 1567–1574.
57. Ingram, I., et al., *Loneliness among people with substance use problems: A narrative systematic review.* Drug and Alcohol Review, 2020. **39**(5): p. 447–483.
58. Stanton, R., et al., *Depression, Anxiety and Stress during COVID-19: Associations with Changes in Physical Activity, Sleep, Tobacco and Alcohol Use in Australian Adults.* Int J Environ Res Public Health, 2020. **17**(11).
59. Mann, F., et al., *Loneliness and the onset of new mental health problems in the general population.* Social Psychiatry and Psychiatric Epidemiology, 2022. **57**(11): p. 2161–2178.
60. Forster, J.J., *Sample Surveys: Nonprobability Sampling*, in *International Encyclopedia of the Social & Behavioral Sciences*, N.J. Smelser and P.B. Baltes, Editors. 2001, Pergamon: Oxford. p. 13467–13470.
61. Lagos, D. and D.L. Compton, *Evaluating the Use of a Two-Step Gender Identity Measure in the 2018 General Social Survey.* Demography, 2021. **58**(2): p. 763–772.
62. Reisner, S.L., et al., *Using a Two-Step Method to Measure Transgender Identity in Latin America/the Caribbean, Portugal, and Spain.* Archives of Sexual Behavior, 2014. **43**(8): p. 1503–1514.
63. Gerlich, M.G. and J. Rehm, *Recall bias in case-crossover designs studying the potential influence of alcohol consumption.* Journal of studies on alcohol and drugs, 2010. **71**(4): p. 619–619.
64. Stockwell, T., et al., *The raising of minimum alcohol prices in Saskatchewan, Canada: impacts on consumption and implications for public health.* American journal of public health, 2012. **102**(12): p. e103–e110.