Self-Reported Mental Health During the COVID-19 Pandemic and its Association with Alcohol and Cannabis Use: A Latent Class Analysis

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Abstract

Background: Mental health problems and substance use co-morbidities during the COVID-19 pandemic are a public health priority. Identifying individuals at high-risk of developing these problems can directly inform mitigating strategies. We aimed to identify distinct groups of individuals (i.e., latent classes) based on patterns of self-reported mental health symptoms and investigate associations with alcohol and cannabis use.

Methods: We used data from six successive waves of a web-based cross-sectional survey of adults aged 18 years and older living in Canada (6,021 participants). We applied latent class analysis to three domains of self-reported mental health: anxiety, depression, and loneliness. Logistic regression was used to characterize latent class membership, estimate the association of class membership with alcohol and cannabis use, and perform sex-based analyses.

Results: We identified two distinct classes: 1) individuals with low scores on all three mental health indicators (no/low-symptoms) and 2) those reporting high scores (high-symptoms). Those at greater risk of being in the high-symptoms class were likely to be women (adjusted odds ratio (aOR) =1.34, 95%CI:1.18-1.52), people worried about getting COVID-19 (aOR=2.39, 95%CI:2.02-2.82), and those with post-secondary education (aOR=1.26, 95%CI:1.02-1.55). Asian ethnicity (aOR=0.78, 95%CI:0.62-0.97), married status (aOR=0.71, 95%CI:0.59-0.85), seniors (aOR=0.38, 95%CI:0.32-0.47), individuals in households with income higher than CAD\$40,000: \$40,000-\$79,000 (aOR=0.73, 95%CI:0.60-0.90), \$80,000-\$119,000 (aOR=0.60, 95%CI:0.48-0.74) and \$120,000+ (aOR=0.47, 95%CI:0.37-0.59) were at lower odds of being in the high-symptoms class. Individuals in the high-symptoms class were more likely to use cannabis at least once a week (aOR=2.25, 95%CI:1.90-2.67), drink alcohol heavily (aOR=1.69, 95%CI:1.47-1.95); and increase the use of cannabis (aOR=3.48, 95%CI:2.79-4.35) and alcohol (aOR=2.37, 95%CI:2.05-2.73) during the pandemic. Women in the high-symptoms class had higher odds of increasing alcohol use than men.

Conclusions: We identified the determinants of experiencing high-symptoms of anxiety, depression, and loneliness, and found a significant association with alcohol and cannabis consumption. This suggests that initiatives and supports are needed to address mental health and substance use multi-morbidities, particularly regarding alcohol use in women.

Introduction

Evidence indicates that the COVID-19 pandemic and related public health directives have led to elevated mental health symptoms, including depression, loneliness, and anxiety among individuals worldwide (1–3). Evidence also shows that social isolation and loneliness, key problems in the context of lockdown orders in effect due to the pandemic, are associated with depression and anxiety disorder (4–6). A review of studies on the mental health impact of the pandemic reported that between 16% and 28% of individuals have reported symptoms of anxiety and depression (7). Another systematic review reported relatively high rates of symptoms of anxiety (6–51%) and depression (15–48%) (8). These studies, though important for reporting prevalence rates, lack data on patterns of responses across mental health conditions. Thus, relatively little is known about how these mental health symptoms may cluster together.

Depression and anxiety are often paired together (9–11). Of people with a diagnosis of depression, 67% had a current and 75% had a lifetime co-morbid anxiety disorder (11). Similarly, of those experiencing anxiety, 63% had a current and 81% had a lifetime depressive disorder (11). Recent studies show that loneliness predicts higher depression and anxiety symptoms,(12) that there is a positive association between loneliness due to the COVID-19 pandemic and anxiety and depressive symptoms,(13) and that loneliness increases the odds for depression, anxiety, and their co-morbidity during the pandemic (14). Since mental health symptoms frequently coexist in people, and risk indicators for co-morbid disorders might differ from those experiencing single disorders,(15, 16) it is important to simultaneously examine mental health symptoms to unveil patterns of co-occurrence and association with substance use. This can be achieved with latent class analysis (LCA), a statistical method that creates groups of individuals with similar patterns of characteristics referred to as latent classes (17). LCA is recognized as a useful tool for studying and classifying mental health disorders at the population level (18). Identifying these classes is important in identifying distinct patterns to determine how mental health disorders cluster together (i.e., class membership) and investigate whether classes change over time and by sex. The identification of groups of individuals with mental health multi-morbidities has important implications for public health policy (resource allocation, raising awareness, or/and further screening) because the presence of multi-morbidity reduces quality of life (19, 20). In addition, it may inform the design of interventions or adapt existing interventions to meet the needs of people with multi-morbidities, particularly when they are at risk of substance abuse.

Evidence shows that mental illness, including symptoms of depression and anxiety, is positively associated with both alcohol (21–23) and cannabis use (24–26). Recent research has shown that individuals consumed more alcohol (27–30) and more cannabis (27, 31, 32) than before the pandemic, with experts suggesting that people may be using alcohol and cannabis to cope with the stressors experienced during the pandemic with important sex differences (2, 33). Alcohol and cannabis use may potentially weaken the immune response in regards to infections (34–39). Thus, it is important to investigate the association between mental health symptoms, and latent class membership, with individuals' substance use behavior during the pandemic. Of particular interest is whether groups of individuals reporting high levels of anxiety, depression, and/or loneliness are more likely to use alcohol and/or cannabis. Such investigations may help improve understanding of mental health and substance use co-morbidities and multi-morbidities during the pandemic to inform and support actions that promote mental health and prevent substance use problems.

We used data from a series of surveys in Canada to: (1) examine latent classes of participants on indicator variables of anxiety, depression, and loneliness during the COVID-19 pandemic using LCA; (2) explore risk factors associated with latent class membership; and (3) estimate the associations of latent class membership with alcohol and cannabis consumption during the COVID-19 pandemic, test the associations for sex and time differences.

Methods

Study design and participants

This study used data from six successive waves of web-based cross-sectional Canada-wide surveys of adults aged 18 years and older. The surveys were conducted in English by the firm Delvinia. The sample was derived from a web-based survey panel, and quota sampling was used to approximate the distribution of the English-speaking Canadian population by age, sex, and region (40). Electronic informed consent was obtained prior to initiating the survey. The study received ethics approval from the Centre for Addiction and Mental Health. The surveys were conducted in six waves in 2020 as follows: May 8–12 (Wave 1, n = 1,005, response rate (RR) = 15.9%), May 29–June 1 (Wave 2, n = 1,002, RR = 17.2%), June 19–23 (Wave 3, n = 1,005, RR = 16.4%), July 10–14 (Wave 4, n = 1,003, RR = 13.7%), September 18–22 (Wave 5, n = 1,003, RR = 17.6%), and November 27–December 1 (Wave 6, n = 1,003, RR = 16.2%). The details of the survey interviews information and RR calculations are in Table A.1 of the Appendix. A pooled sample of 6,021 participants (Waves 1–6) was analyzed in this study. These data were collected at different points to permit an examination of variation in the impact of COVID-19-related stressors on participants over time.

Measures

Mental health indicators

We identified anxiety among participants using the 7-item generalized anxiety disorder, using the GAD-7 scale, which is based on 4-point Likert-scale questions. These items measure the frequency of anxiety symptoms over the past two weeks and are scored from 0 (not at all) to 3 (nearly every day). The summary score ranged from 0 to 21 (41). A score ≥ 10 suggests moderate or severe anxiety to consider treatment, (42) which has clinical relevance. The literature that have studied GAD-7 scale have also validated the cut-off of 10 (42–44). We then constructed a binary variable for anxiety to identify participants with moderate or severe anxiety symptoms (45).

Participants who felt depressed were identified using a question from the Center for Epidemiologic Studies Depression Scale (CES-D) (46): “In the past 7 days, how often have you felt depressed?” Response options included: “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)”. Participants who reported feeling depressed 3–4 or more days in the previous week were classified as experiencing depressive symptoms (46). Similarly, loneliness was measured with a single item from the CES-D (46) with the same response options: “In the past 7 days, how often have you felt lonely?” Participants were considered to be lonely if they reported feeling lonely for 3–4 or more days in the previous week (46).

Although LCA is a data-driven method, extra steps are needed to ensure that identified classes are interpretable and not simply statistical artefacts (47). We described the classes and determined the factors that are associated with the classes.

Alcohol and cannabis use variables

Four variables related to alcohol and cannabis use were assessed. For alcohol, a binary variable identifying heavy episodic drinkers was derived based on the responses to the question: “On how many of the past seven days did you drink four (if woman) or five (if man) or more drinks on one occasion?” Men who consumed five (four for women) or more drinks per occasion at least four days per week were coded as heavy episodic drinkers. Note that a drink was defined as a 12 oz. bottle of beer or cider/cooler (5% alcohol content), a 5 oz. glass of wine (12% alcohol content), or a straight or mixed drink with 1.5 oz. of liquor (40% alcohol content). The second alcohol use question examined whether people’s drinking increased due to the pandemic. Participants were asked: “In the past seven days, did you drink more alcohol, about the same or less alcohol overall than you did before the COVID-19 pandemic started?” This measure was coded to reflect an increase in alcohol use as: 0 (much less, slightly less, or same), and 1 (slightly more or much more).

For cannabis use, participants were asked: “During the past seven days, on how many days did you use cannabis?” A binary measure was created to reflect any cannabis use (use on one or more days) versus no cannabis use in the past week. Increase in cannabis use was also measured with the question: “In the past 7 days, did you use cannabis more often, about the same, or less often overall than you did before the COVID-19 pandemic started?” This was coded to reflect an increase in cannabis use as follows: 0 (much less, slightly less, or same), and 1 (slightly more or much more).

Covariates

We included several individual and household covariates: sex, age (18–39, 40–59 and 60 years or more), marital status (married/living with partner, separated/divorced/widowed and single), educational status (high school or less, some post-secondary, college degree/diploma and university degree/diploma), racial group (White, Asian, Black/Indigenous/Arab/Latinos and other ethnicities), residential environment (urban, suburban and rural), household income (less than \$40,000, \$40,000–\$79,999, \$80,000–\$119,999, \$120,000 or more, and ‘prefer not to answer’), having children under 18 in the household and household composition (living alone or living with others). We also included a variable indicating the extent of worry experienced regarding contracting COVID-19, based on responses to the question: “How worried are you that you or someone close to you will get ill from COVID-19?”, with possible responses provided on a 4-point Likert scale of: “very worried”, “somewhat worried”, “not very worried”, and “not at all worried”. We derived a binary variable to compare those classified as worried (i.e., very or somewhat worried) versus those not worried (i.e., not very or not at all worried). We accounted for time effects by adding a binary variable for each wave.

Statistical analyses

We used LCA to identify classes of participants with similar patterns of reported mental health symptoms during the pandemic. We used the three mental health indicators (anxiety, depression, loneliness) to divide participants into mutually exclusive and exhaustive latent classes. Using LCA, we estimated the probability for each participant of being in a particular class based on their responses to all three indicator items. We used the gsem command in Stata to fit the latent class model.

To determine the optimal number of latent classes, we estimated latent class models using different class numbers and we used the Akaike’s (AIC) and the Bayesian information criterion (BIC) to select the model with the better fit.(48)

To assess the associations of latent class memberships with alcohol and cannabis use, we used multivariate logistic regression. We adjusted for individual participant confounders (sex, age, education, marital status, ethnicity, residential environment), household confounders (income, presence of children, presence of other persons in the home), worrying about getting COVID-19, and survey wave indicator variables. We tested for sex differences by including latent class by sex interactions. We also included latent class by wave interaction terms to assess whether and how the association of class membership with alcohol and cannabis use changed over time. We then calculated the F-test for the joint significance of interaction terms to detect time/wave effects. We also regressed anxiety, depression and loneliness variables on alcohol and cannabis use to assess the association of individual mental health symptoms on alcohol and cannabis use.

We presented descriptive statistics of the cohort, including percentages and number of observations. We also reported adjusted odds ratios (aORs) with 95% confidence intervals (CIs), and presented results by sex. We used Stata (version 16.0) for all analyses. The full estimation tables are in the Appendix (Table A.2–3).

Results

A total of 6,021 participants completed the survey across the six waves, with at least 1,000 participants per wave. In Table 1, we report the number and the percentage of participants for each self-reported measure of mental health symptom, alcohol and cannabis use, as well as participants' characteristics within each wave, and for the total sample (all six waves). Overall, the percentage of participants who reported severe/moderate anxiety, depression, and loneliness were quite similar across the waves and in the full sample (ranging between 19–25%, 18–22%, and 20–24%, respectively). Between 12–16% of participants reported using cannabis at least once a week, and 24–27% reported engaging in heavy episodic drinking. Regarding change in cannabis and alcohol use, a total of 401 (7%) and 1,295 (22%) participants reported having increased their use of cannabis and alcohol.

Latent class modeling and identification of classes

Models with one to four latent classes for each wave and for pooled waves were estimated and compared using the information criteria (see Table A.4 in the Appendix). All three criteria (Log-likelihood, AIC and BIC) indicated that the two-class models resulted in a better fit than other models. However, we also characterized used the three-class model and estimated the association between three-latent class variable and substance use to assess sensitivity of the results to the number of class (results for the three-class model are in the Table A.5–6 in Appendix).

Table 1
Descriptive statistics: Mental health indicators, substance use and sociodemographic characteristics

	Wave 1		Wave 2		Wave 3		Wave 4		Wave 5		Wave 6		All waves	
Variables	n	%	n	%	n	%	n	%	n	%	n	%	n	%
<i>Mental health indicators</i>														
Moderate/severe anxiety	256	25.5%	215	21.5%	196	19.5%	193	19.2%	212	21.1%	244	24.3%	1319	21.9%
Felt depressed	205	20.4%	212	21.2%	185	18.4%	188	18.7%	213	21.2%	218	21.7%	1222	20.3%
Felt lonely	233	23.2%	237	23.7%	211	21.0%	231	23.0%	202	20.1%	234	23.3%	1349	22.4%
<i>Alcohol and cannabis use</i>														
Cannabis use past week	115	11.5%	130	13.0%	124	12.4%	131	13.1%	119	11.9%	160	16.0%	781	13.0%
Heavy Episodic Drinking	238	23.7%	247	24.7%	267	26.6%	271	27.2%	255	25.5%	257	25.7%	1537	25.6%
Increase in cannabis use	64	6.4%	70	7.0%	59	5.9%	62	6.2%	53	5.3%	93	9.3%	401	6.7%
Increase in alcohol use	253	25.2%	244	24.4%	216	21.5%	209	20.8%	168	16.7%	208	20.7%	1295	21.5%
<i>Covariates</i>														
Men	504	50.1%	492	49.1%	501	49.9%	502	50.0%	497	49.6%	492	49.1%	2986	49.6%
Women	498	49.6%	497	49.6%	499	49.7%	492	49.1%	498	49.7%	503	50.1%	2986	49.6%
Living with others	797	79.5%	788	78.9%	787	78.7%	799	79.9%	797	79.6%	796	79.8%	4763	79.4%
Living alone	205	20.5%	211	21.1%	213	21.3%	201	20.1%	204	20.4%	201	20.2%	1236	20.6%
Presence of children	229	22.8%	236	23.6%	237	23.6%	242	24.1%	234	23.3%	216	21.5%	1397	23.2%
No children	776	77.2%	766	76.4%	768	76.4%	761	75.9%	769	76.7%	787	78.5%	4624	76.8%
Income less than \$40K	128	12.7%	121	12.1%	136	13.5%	118	11.8%	116	11.6%	110	11.0%	729	12.1%
Income in \$40,000-\$79,999	268	26.7%	236	23.6%	238	23.7%	235	23.4%	247	24.6%	236	23.5%	1457	24.2%
Income in \$80,000-\$119,999	226	22.5%	229	22.9%	220	21.9%	213	21.2%	237	23.6%	241	24.0%	1367	22.7%
Income \$120,000+	217	21.6%	259	25.8%	247	24.6%	252	25.1%	228	22.7%	251	25.0%	1451	24.1%
Income missing	166	16.5%	157	15.7%	164	16.3%	185	18.4%	175	17.4%	165	16.5%	1012	16.8%
College	190	18.9%	211	21.1%	189	18.8%	204	20.3%	183	18.2%	221	22.0%	1198	19.9%
High school	111	11.0%	104	10.4%	129	12.8%	122	12.2%	119	11.9%	99	9.9%	686	11.4%
Post-secondary	159	15.8%	165	16.5%	148	14.7%	162	16.2%	147	14.7%	150	15.0%	933	15.5%
University	538	53.5%	516	51.5%	531	52.8%	502	50.0%	548	54.6%	521	51.9%	3155	52.4%
Asian	200	19.9%	175	17.5%	201	20.0%	188	18.7%	190	18.9%	202	20.1%	1156	19.2%
Black/Indigenous/Arab/Latino and other ethnicities	87	8.7%	96	9.6%	93	9.3%	92	9.2%	88	8.8%	86	8.6%	542	9.0%
White	698	69.5%	702	70.1%	691	68.8%	697	69.5%	699	69.7%	691	68.9%	4179	69.4%
Urban	465	46.3%	459	45.8%	485	48.3%	467	46.6%	463	46.2%	474	47.3%	2812	46.7%
Suburban	382	38.0%	379	37.8%	369	36.7%	365	36.4%	376	37.5%	365	36.4%	2234	37.1%
Rural	158	15.7%	164	16.4%	151	15.0%	171	17.0%	164	16.4%	164	16.4%	969	16.1%
Separated	128	12.7%	132	13.2%	119	11.8%	122	12.2%	113	11.3%	118	11.8%	735	12.2%
Married	613	61.0%	605	60.4%	622	61.9%	634	63.2%	638	63.6%	653	65.1%	3763	62.5%
Single	251	25.0%	251	25.0%	253	25.2%	233	23.2%	239	23.8%	216	21.5%	1445	24.0%
Age 18–39	394	39.2%	389	38.8%	394	39.2%	388	38.7%	390	38.9%	392	39.1%	2348	39.0%
Age 40–59	306	30.4%	312	31.1%	307	30.5%	309	30.8%	305	30.4%	305	30.4%	1842	30.6%
Age 60+	305	30.3%	301	30.0%	304	30.2%	306	30.5%	308	30.7%	306	30.5%	1830	30.4%
Total respondents	1005	100%	1002	100%	1005	100%	1003	100%	1003	100%	1003	100%	6021	100%

Table 2 presents the models with two classes and their estimated membership proportions for each wave and for the full sample. The largest proportion of participants is found in Class 1 (75.6%) with around 24.4% in Class 2. Each class corresponds to an underlying subgroup of participants that can be

characterized by a particular pattern of mental health indicators during the COVID-19 pandemic. In particular, Class 2 appears to represent participants with high scores on all three mental health indicators (anxiety, feeling depressed, and feeling lonely). In this class, participants are more likely to be depressed, lonely, and anxious, with probabilities around 0.8, 0.7, and 0.7, respectively. As such, we will refer to Class 2 as the “high-symptoms class”. In contrast, Class 1 contains participants with low scores on all three mental health indicators, who have a low probability of moderate to severe anxiety, feeling depressed, and feeling lonely (probabilities of 0.01, 0.07 and 0.06, respectively). We refer to Class 1 as the “no/low-symptoms class.” The characteristics of these two classes are consistent across the six waves. Table A.5 displays three classes’ results: no/low-symptoms (68.9% of participants), moderate-symptoms (14%), and high-symptoms (17.1%).

Sex-specific LCA analyses were conducted to determine whether the latent classes were different for men and women. The results reported in the two last panels of Table 2 show that patterns for men and women are similar to those found for the pooled sample, with a “no/low-symptoms” class and a “high-symptoms” class.

Table 2
Description of latent classes for the total sample, the women subsample, and the men subsample across waves

	All waves		Wave 1		Wave 2		Wave 3		Wave 4		Wave 5		Wave 6	
	Class 1	Class 2	Class 1	Class 2	Class 1	Class 2	Class 1	Class 2	Class 1	Class 2	Class 1	Class 2	Class 1	Class 2
Total sample														
Proportion of respondents in each class (%)	75.6	24.4	73.9	26.1	76.2	23.8	76.3	23.7	76.0	24.0	77.1	22.9	74.1	25.9
Proportion of respondents that														
Felt depressed (%)	1.5	78.5	0.4	77.0	0.9	85.8	1.5	72.9	1.1	74.5	3.0	82.7	2.1	77.9
Felt lonely (%)	7.0	69.9	8.7	64.3	8.7	71.4	6.0	69.3	7.9	70.9	5.0	71.0	5.9	73.2
Felt anxious (%)	5.7	71.8	6.2	80.2	7.0	67.6	4.9	66.5	3.7	68.3	5.4	74.1	7.1	73.6
Number of respondents	6,021		1,005		1,002		1,005		1,003		1,003		1,003	
Subsample of women														
Proportion of respondents in each class (%)	73.0	27.0	70.6	29.4	76.1	23.9	73.9	26.1	72.0	28.0	70.8	29.2	72.7	27.3
Proportion of respondents that														
Felt depressed (%)	2.3	78.7	1.8	79.0	2.9	87.3	3.8	75.0	0.0	71.9	1.4	77.7	3.6	79.3
Felt lonely (%)	8.2	69.7	9.7	69.5	9.7	75.0	6.8	69.5	9.8	60.6	6.0	65.2	6.8	77.2
Felt anxious (%)	6.4	71.6	8.1	80.8	7.3	74.3	5.6	64.6	3.2	63.6	5.2	70.5	8.6	72.4
Number of respondents	2,987		498		497		499		492		498		503	
Subsample of men														
Proportion of respondents in each class (%)	78.6	21.4	78.2	21.8	79.1	20.9	79.5	20.5	79.5	20.5	82.5	17.5	75.9	24.1
Proportion of respondents that														
Felt depressed (%)	0.7	78.3	0.0	74.5	0.0	89.3	0.0	71.1	1.4	75.3	3.9	88.6	0.9	75.5
Felt lonely (%)	5.9	70.2	7.7	59.7	8.1	69.6	5.2	71.2	5.9	82.5	4.1	79.7	5.2	67.8
Felt anxious (%)	5.1	72.0	4.3	81.7	7.2	61.9	4.5	71.2	4.0	72.2	5.1	78.2	5.7	75.6
Number of respondents	2,987		504		492		501		501		497		492	

Factors associated with high-symptoms class membership

We used logistic regression to identify factors associated with class membership in the total sample and within each wave’s data (see Table 3). We regressed the binary variable which indicated whether or not individuals were in the high-symptoms class based on individual and household characteristics. The adjusted odds ratios are reported in Table 3. From the total sample, women (aOR = 1.34, 95%CI: 1.18–1.52) and participants with a post-secondary level of education (aOR = 1.26, 95%CI: 1.02–1.55) were at greater odds of being in this class than men and those with a college diploma. Individuals who reported being worried about contracting COVID-19 were also at greater odds of being in the high symptoms class (aOR = 2.39, 95%CI: 2.02–2.82). People who were married (aOR = 0.71, 95%CI: 0.59–0.85), aged 60+ (aOR = 0.38, 95%CI: 0.32–0.47) and with incomes higher than CAD\$40,000: between \$40,000-\$79,000 (aOR = 0.73, 95%CI: 0.60–0.90), \$80,000-\$119,000 (aOR = 0.60, 95%CI: 0.48–0.74) and \$120,000+ (aOR = 0.47, 95%CI: 0.37–0.59) were less likely than single, younger age groups, and people in lower income groups, to be in the high-symptoms class. Those who self-identified as Asian (aOR = 0.78, 95%CI: 0.62–0.97) were less likely to be in the high-symptoms class compared to people who self-identified as Black/Indigenous/other ethnicities.

Across waves, the results show some heterogeneity suggesting that risk factors for reporting a high-symptoms level of mental health may vary at different time points. For example, women's odds ratios were significantly greater than one in Waves 1, 3, or 5 (aOR = 1.56, 95%CI:1.14–2.12; aOR = 1.48, 95%CI:1.08–2.03; aOR = 1.63, 95%CI:1.14–2.31) and not significantly different from zero in Waves 2, 4, and 6. Note that individuals who worried about contracting COVID-19 were consistently at greater odds of being in the high-symptoms class, whereas those aged 60+ were consistently less likely to be in this group.

Table 3
Factors associated with high-level mental health symptoms class membership (Adjusted Odds Ratios)

	Wave 1	Wave 2	Wave 3	Wave 4	Wave5	Wave 6	all waves
Women	1.56*** (1.14–2.12)	1.22 (0.88–1.67)	1.48** (1.08–2.03)	1.17 (0.86–1.61)	1.63*** (1.14–2.31)	1.15 (0.85–1.56)	1.34*** (1.18–1.52)
Worry about contracting COVID-19	3.61*** (2.27–5.75)	2.40*** (1.62–3.57)	1.73*** (1.18–2.53)	2.50*** (1.66–3.75)	3.10*** (1.88–5.09)	2.01*** (1.33–3.05)	2.39*** (2.02–2.82)
Living with others	1.07 (0.65–1.77)	0.95 (0.57–1.57)	1.54 (0.95–2.52)	0.82 (0.50–1.35)	0.74 (0.44–1.24)	1.18 (0.72–1.92)	1.03 (0.85–1.26)
Presence of children	1.14 (0.77–1.69)	1.17 (0.80–1.73)	0.73 (0.47–1.12)	1.27 (0.85–1.91)	1.96*** (1.26–3.05)	0.87 (0.58–1.31)	1.14 (0.97–1.35)
Income $\leq$ \$40,000	REF	REF	REF	REF	REF	REF	REF
Income of \$40,000-\$79,999	0.74 (0.44–1.22)	0.73 (0.44–1.19)	0.68 (0.42–1.12)	0.98 (0.59–1.63)	0.55** (0.31–0.98)	0.67 (0.40–1.12)	0.73*** (0.60–0.90)
Income of \$80,000-\$119,999	0.86 (0.51–1.48)	0.40*** (0.23–0.71)	0.52** (0.30–0.89)	0.73 (0.42–1.28)	0.42*** (0.23–0.76)	0.58 (0.34–1.01)	0.60*** (0.48–0.74)
Income \$120,000+	0.63 (0.35–1.11)	0.23*** (0.13–0.41)	0.29*** (0.16–0.53)	0.87 (0.50–1.53)	0.54 (0.30–1.00)	0.39*** (0.22–0.69)	0.47*** (0.37–0.59)
Income missing	0.61 (0.34–1.10)	0.39*** (0.21–0.72)	0.45*** (0.25–0.82)	0.73 (0.41–1.28)	0.41*** (0.22–0.77)	0.58 (0.33–1.04)	0.55*** (0.44–0.69)
College diploma	REF	REF	REF	REF	REF	REF	REF
High school	1.11 (0.62–1.96)	0.73 (0.40–1.36)	0.85 (0.48–1.50)	1.04 (0.58–1.85)	1.82 (0.96–3.44)	0.83 (0.46–1.48)	0.99 (0.79–1.26)
Post-secondary	1.11 (0.67–1.84)	1.42 (0.86–2.37)	1.09 (0.64–1.85)	0.93 (0.55–1.58)	1.96** (1.07–3.59)	1.22 (0.74–2.00)	1.26** (1.02–1.55)
University	0.79 (0.53–1.19)	0.98 (0.64–1.48)	0.95 (0.61–1.47)	1.09 (0.72–1.63)	1.13 (0.70–1.81)	1.19 (0.80–1.77)	1.01 (0.85–1.19)
Black/Indigenous/Arab/Latino and other ethnicities	REF	REF	REF	REF	REF	REF	REF
Asian	0.64 (0.37–1.12)	1.13 (0.64–2.02)	0.52** (0.30–0.90)	0.91 (0.52–1.58)	0.93 (0.50–1.72)	0.65 (0.38–1.11)	0.78** (0.62–0.97)
White	0.70 (0.44–1.14)	1.24 (0.75–2.05)	0.58** (0.36–0.93)	0.80 (0.49–1.31)	0.92 (0.53–1.60)	0.84 (0.53–1.34)	0.83 (0.69–1.01)
Rural	REF	REF	REF	REF	REF	REF	REF
Urban	1.47 (0.91–2.37)	1.05 (0.65–1.70)	1.23 (0.75–2.04)	0.77 (0.49–1.21)	1.68 (0.99–2.85)	0.73 (0.47–1.14)	1.13 (0.93–1.36)
Suburban	1.25	1.01	0.95	0.76	0.94	0.85	0.98

	Wave 1	Wave 2	Wave 3	Wave 4	Wave5	Wave 6	all waves
	(0.76– 2.06)	(0.62– 1.67)	(0.57– 1.60)	(0.48– 1.22)	(0.54– 1.64)	(0.55– 1.33)	(0.80– 1.19)
Single	REF	REF	REF	REF	REF	REF	REF
Separated	1.28	1.53	1.87**	0.90	0.65	1.17	1.14
	(0.72– 2.27)	(0.87– 2.68)	(1.04– 3.36)	(0.52– 1.57)	(0.33– 1.28)	(0.66– 2.06)	(0.90– 1.43)
Married	0.89	1.06	0.75	0.55**	0.47***	0.77	0.71***
	(0.57– 1.40)	(0.68– 1.65)	(0.46– 1.20)	(0.34– 0.87)	(0.29– 0.76)	(0.48– 1.22)	(0.59– 0.85)
Age 18–39	REF	REF	REF	REF	REF	REF	REF
Age 40–59	0.79	0.92	1.00	0.75	0.96	0.92	0.90
	(0.55– 1.13)	(0.64– 1.33)	(0.68– 1.47)	(0.51– 1.09)	(0.65– 1.42)	(0.64– 1.32)	(0.78– 1.05)
Age 60+	0.38***	0.26***	0.36***	0.47***	0.27***	0.34***	0.38***
	(0.24– 0.61)	(0.15– 0.44)	(0.22– 0.60)	(0.29– 0.77)	(0.15– 0.51)	(0.22– 0.55)	(0.32– 0.47)
Wave 1							0.92
							(0.74– 1.14)
Wave 2							0.93
							(0.75– 1.15)
Wave 3							0.83
							(0.67– 1.03)
Wave 4							0.86
							(0.69– 1.07)
Wave 5							0.91
							(0.74– 1.13)
Wave 6	REF	REF	REF	REF	REF	REF	REF
Constant	0.18***	0.31***	0.47	0.44	0.21***	0.57	0.37***
	(0.07– 0.48)	(0.13– 0.75)	(0.19– 1.13)	(0.18– 1.09)	(0.08– 0.59)	(0.24– 1.37)	(0.25– 0.55)
Observations	1,002	999	1,000	1,000	1,001	997	5,999
Pseudo R-squared	0.077	0.097	0.091	0.066	0.148	0.058	0.069
Legend: 95% confidence level in parentheses. Significance level *** p < 0.01, ** p < 0.05.							

Associations of high-symptoms class membership with alcohol and cannabis use

Table 4 displays associations of class membership with alcohol and cannabis use in the total sample and by sex, controlling for sex, age, marital status, education, ethnicity, living area, household confounders, worrying about getting COVID-19, and survey wave indicator variables. Individuals in the high-symptoms class were at greater odds of using cannabis at least once a week and frequently engaging in heavy episodic drinking (aOR = 2.25, 95%CI:1.90–2.67; aOR = 1.69, 95%CI:1.47–1.95) relative to those in the no/low-symptoms class. Regarding changes in cannabis and alcohol consumption, results indicated that being in the high-symptoms class was associated with greater odds of increasing cannabis and alcohol use during the pandemic (aOR = 3.48, 95%CI:2.79–4.35; aOR = 2.37, 95%CI:2.05–2.73).

Table 4
Associations of high-symptoms class membership with alcohol and cannabis use during the pandemic (Adjusted odds ratios)

	Cannabis use past week	Heavy episodic drinking	Increase in cannabis use	Increase in alcohol use
Total sample				
High-symptoms class	2.25***	1.69***	3.48***	2.37***
	(1.90–2.67)	(1.47–1.95)	(2.79–4.35)	(2.05–2.73)
Subsample of women				
High-symptoms class	1.96***	1.66***	2.87***	2.09***
	(1.53–2.52)	(1.37–2.02)	(2.04–4.03)	(1.71–2.56)
Subsample of men				
High-symptoms class	2.53***	1.72***	3.87***	2.62***
	(2.00–3.20)	(1.40–2.10)	(2.86–5.25)	(2.12–3.24)
Legend: 95% confidence level in parentheses. Significance level *** $p < 0.01$, ** $p < 0.05$.				
Note: Odds ratios adjusted for sex, age, marital status, education, ethnicity, living area, household income, the presence of children, and other people in the household (see the Appendix for the full estimation table).				

Table 5 reported aORs controlling for high-symptoms class*women interactions to test if high-symptoms class interacts with sex. Results show that aORs were similar for men and women, except for increase in alcohol use – suggesting that women with high-symptoms were at greater odds of increasing alcohol drinking during the pandemic than men with high-symptoms.

Table 5
Adjusted odds ratios from model with sex and latent class membership interaction

	Cannabis use past week	Heavy Episodic Drinking	Increase in cannabis use	Increase in alcohol use
High-symptoms class	2.52***	1.75***	4.01***	2.82***
	(2.00–3.17)	(1.44–2.13)	(3.00–5.37)	(2.30–3.47)
High-symptoms class*women	0.79	0.94	0.72	0.72**
	(0.57–1.10)	(0.72–1.22)	(0.46–1.11)	(0.54–0.95)
Legend: 95% confidence level in parentheses. Significance level *** $p < 0.01$, ** $p < 0.05$.				
Note: Odds ratios are adjusted for sex, age, marital status, education, ethnicity, living area, household income, the presence of children, and other people in the household.				

Table A.6 displays similar results when considering three classes although the magnitude of the associations are smaller. Note that using anxiety, depression and loneliness variables as dependent variables to estimate their associations with alcohol and cannabis use did not provide consistent evidence particularly by sex (see Table A.7 in the Appendix).

Finally, we investigated whether the associations between class membership and cannabis and alcohol consumption varied across the survey waves. The results are in Table 6. The t-test for each interaction term (high-symptoms class*wave) indicates that the association between class membership and cannabis use/heavy episodic drinking (at the level of 5%) do not change across waves. Similar results are observed for increase in cannabis use. For increase in alcohol use, two interaction terms: high-symptoms class*wave1 and high-symptoms class*wave5 were statistically different from zero, suggesting that the odds ratios were significantly greater for Wave 1 and Wave 5 than for the other waves. To test if the odds ratios across waves are all statistically equal, we tested the null hypothesis that all the coefficients of the interaction terms are zero, using an F-test separating the total sample, and the man subsample, and the woman subsample. All the F-tests results (Table 6) have p-values greater than 5%, except for increase in alcohol use (p-value < 0.05 in the total sample and man subsample). This suggests that, overall, being in the high-symptoms class for alcohol and cannabis use was not affected by time. However, we rejected that all the interaction terms were simultaneously zero for increase in alcohol use for the total sample and the man subsample, suggesting that the association of high-symptoms class membership and the change in drinking behaviour varies across time, particularly for men.

Table 6
Adjusted odds ratios from model with time and latent class membership interaction

	Cannabis use past week	Heavy Episodic Drinking	Increase in cannabis use	Increase in alcohol use
Total sample				
High-symptoms class	2.30***	1.99***	3.84***	3.38***
	(1.59–3.33)	(1.44–2.73)	(2.42–6.10)	(2.41–4.73)
High-symptoms class*wave 1	0.95	1.13	0.60	0.61**
	(0.54–1.64)	(0.72–1.77)	(0.30–1.21)	(0.38–0.97)
High-symptoms class*wave 2	0.84	0.77	1.04	0.79
	(0.49–1.46)	(0.49–1.21)	(0.52–2.08)	(0.49–1.26)
High-symptoms class*wave 3	0.91	0.77	0.74	0.65
	(0.52–1.58)	(0.48–1.21)	(0.37–1.52)	(0.40–1.06)
High-symptoms class*wave 4	0.97	0.84	0.90	0.78
	(0.56–1.67)	(0.53–1.33)	(0.45–1.83)	(0.48–1.26)
High-symptoms class*wave 5	1.26	0.67	1.30	0.44***
	(0.72–2.19)	(0.43–1.06)	(0.61–2.77)	(0.27–0.73)
F-test chi2 statistics	2.15	6.68	4.66	12.11
F-test p_value	0.828	0.246	0.458	0.033
Subsample of women				
High-symptoms class	1.98**	1.67**	3.12***	2.31***
	(1.11–3.52)	(1.06–2.62)	(1.53–6.35)	(1.44–3.68)
High-symptoms class*wave 1	0.99	1.35	0.42	0.78
	(0.42–2.30)	(0.71–2.57)	(0.15–1.19)	(0.41–1.47)
High-symptoms class*wave 2	0.93	0.98	1.18	0.77
	(0.41–2.09)	(0.50–1.93)	(0.41–3.42)	(0.39–1.50)
High-symptoms class*wave 3	0.71	0.96	0.68	1.14
	(0.31–1.62)	(0.51–1.80)	(0.23–2.02)	(0.59–2.20)
High-symptoms class*wave 4	1.02	0.97	1.09	1.23
	(0.43–2.44)	(0.51–1.87)	(0.33–3.65)	(0.62–2.44)
High-symptoms class*wave 5	1.47	0.80	1.83	0.67
	(0.64–3.37)	(0.41–1.53)	(0.56–5.96)	(0.33–1.34)
F-test chi2 statistics	2.90	2.64	6.96	4.76
F-test p_value	0.715	0.756	0.224	0.446
Subsample of men				
High-symptoms class	2.47***	2.24***	4.10***	4.74***
	(1.49–4.09)	(1.41–3.56)	(2.19–7.68)	(2.87–7.83)
High-symptoms class*wave 1	1.02	1.06	0.84	0.52
	(0.48–2.17)	(0.55–2.05)	(0.33–2.16)	(0.26–1.04)
High-symptoms class*wave 2	0.70	0.64	0.94	0.80
	(0.32–1.55)	(0.33–1.23)	(0.36–2.44)	(0.40–1.58)
High-symptoms class*wave 3	1.19	0.59	0.88	0.36***
	(0.55–2.60)	(0.30–1.16)	(0.34–2.33)	(0.17–0.74)
High-symptoms class*wave 4	1.08	0.75	0.93	0.52
	(0.52–2.25)	(0.39–1.47)	(0.37–2.32)	(0.26–1.05)

	Cannabis use past week	Heavy Episodic Drinking	Increase in cannabis use	Increase in alcohol use
High-symptoms class*wave 5	1.29	0.64	1.09	0.30***
	(0.60–2.78)	(0.33–1.24)	(0.40–2.99)	(0.14–0.64)
F-test chi2 statistics	2.37	5.41	0.29	14.96
F-test p_value	0.796	0.368	0.998	0.011
Legend: 95% confidence level in parentheses. Significance level *** $p < 0.01$, ** $p < 0.05$.				
Note: Odds ratios are adjusted for sex, age, marital status, education, ethnicity, living area, household income, the presence of children, and other people in the household (see the Appendix for the full estimation table and the model specification).				

Discussion

We found two classes of individuals: those with high scores on all three mental health indicators and those with no/low symptoms. The two classes were consistently identified across survey waves, which suggested that the classification was robust. The high-symptoms class was our class of interest and it contained around 23–26% of the participants with a high probability of being anxious, feeling depressed, and feeling lonely.

We found that women and participants with a post-secondary education level were more likely to be in the high-symptoms class, while Asians, married, senior individuals, and participants in households with incomes higher than CAD\$40,000 were less likely to belong to the high-symptoms class. Individuals worried about getting COVID-19 were also more likely to belong to the high-symptoms class. Additionally, we showed that high-symptoms class membership was associated with increased odds of using cannabis and heavy episodic drinking relative to the no/low-symptoms class. Increases in cannabis as well as alcohol use were also associated with class membership. These effects did not differ across survey waves.

These findings should be considered in the context of several limitations. First, although quota sampling is the non-probability sampling method that is the closest in representativeness to probability sampling, (49) its non-randomness may lead to potential selection bias (50). However, comparing quota and probability sampling, Cumming (1990) (51) found that quota sampling with age and sex quota controls may be an acceptable alternative to probability sampling. Second, our results may not be generalizable to the general population. Finally, cross-sectional data were collected; therefore, conclusions regarding causal relationships could not be made. Nevertheless, the study offers useful insights into understanding mental health and substance use co-morbidities and multi-morbidities during the COVID-19 pandemic.

Our first finding clearly identifies a group of individuals who experienced high-level mental health symptoms, and suggests that the well-established co-morbidity of anxiety and depression might also coexist with feelings of loneliness during the COVID-19 pandemic. This finding is consistent with previous studies demonstrating an association between loneliness, depression, anxiety and their co-morbidity (13, 14, 52). The second main finding reveals that worrying about contracting COVID-19 (and/or fear of someone close getting COVID-19) was the main risk factor for experiencing high-level mental health symptoms. This result suggests that mental health symptoms during the pandemic could be reduced by reducing the fear of COVID-19 within the population. Effective communication strategies employed during the pandemic from governments or public health authorities might help to enhance the long-term psychological well-being of people and mitigate the fear of contracting the COVID-19 virus (53–55).

The fourth main finding reveals that people (regardless of their sex) who are at a high-symptoms level (compared to no/low-symptoms) were more likely to increase the use of cannabis and alcohol during the pandemic, suggesting that people with a high-symptoms level may be turning to substances to help alleviate negative symptoms. Women tend to increase their alcohol use during the pandemic that men. This finding corroborates the fact that COVID-19 psychological distress is associated to drinking more in women than men (56). However, using alcohol and cannabis to deal with symptoms of anxiety and depression or with life challenges can increase the risk of developing alcohol or cannabis use disorder, or both (57). Moreover, in the longer term, substance misuse can worsen these emotional disorder symptoms. This implies that treatment programs are needed to better address the co-morbid disorders in response to the mental health effects of the pandemic.

Our results suggest that initiatives (e.g., screening, virtual consultation) aimed at improving population mental health and substance use problems during the pandemic should be adapted to account for sex, age, ethnicity, marital status, and socioeconomic status, while prioritizing women and post-secondary-educated individuals. These initiatives should also integrate effective communication strategies with the goal of reducing people's fear of contracting the virus, and encouraging behaviors that reduce the spread of COVID-19. The results also suggest that each psychiatric consultation should be paired with screening for substance use disorders, particularly women should be screen for alcohol misuse.

Conclusions

We identified an important group of individuals with high levels of anxiety, depression, and loneliness during the COVID-19 pandemic who tended to drink more alcohol and use more cannabis compared to those with no/low-symptoms. This finding suggests that initiatives and supports are needed to address mental health and substance use multi-morbidities, particularly during the COVID-19 pandemic.

Abbreviations

COVID-19
Coronavirus disease 2019

LCA
Latent class analysis
GAD
generalized anxiety disorder
CES-D
Center for Epidemiologic Studies Depression
AIC
Akaike information criterion
BIC
Bayesian information criterion
aOR
Adjusted odds ratio
CI
Confidence interval
RR
Response rate

Declarations

Ethics approval and consent to participate

The study has been granted ethics committee approval from the Research Ethics Board at the Centre for Addiction and Mental Health, Toronto, ON, Canada. The Centre For Addiction and Mental Health Research Ethics Board (CAMH REB) operates in compliance with, and is constituted in accordance with, the requirements of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 2), the International Conference on Harmonisation Good Clinical Practice Consolidated Guideline (ICH GCP), Part C, Division 5 of the Food and Drug Regulations, Part 4 of the Natural Health Products Regulations, Part 3 of the Medical Devices Regulations, and the provisions of the Ontario Personal Health Information Protection Act (PHIPA 2004) and its applicable regulations. The CAMH REB is qualified through the CTO REB Qualification Program and is registered with the U.S. Department of Health and Human Services (DHHS) Office for Human Research Protection (OHRP). All participants provided a written consent to participate.

Consent for publication

N.A.

Availability of data

All data generated or analysed during this study are included in this published article [and its supplementary information files]. Data are also publicly available for download at: <http://www.delvinia.com/coronavirus/>.

Competing interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Authors' contributions

JR, SA, SW and NHS came up the paper idea. SW, DF, SA, and NHS conceptualized and designed the study. HAH and TEM developed the survey questionnaires for the data collection. NHS analyzed the data, and drafted the manuscript. All co-authors read and critically revised successive draft of the manuscript. All authors read and approved the final manuscript.

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