ORIGINAL ARTICLE

A longitudinal approach to understanding risk factors for problem alcohol use during the COVID-19 pandemic

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Abstract

Background: We conducted a longitudinal study to examine person-centered heterogeneity in problem drinking risk during the 2019 Coronavirus disease (COVID-19) pandemic. We aimed to differentiate high- from low-risk subgroups of drinkers during the pandemic, to report on the longitudinal follow-up of the baseline sample reported in Wardell et al. (*Alcohol Clin Exp Res*, **44**, 2020, 2073), and to examine how subgroups of drinkers differed on coping-related and pre-pandemic alcohol vulnerability factors.

Methods: Canadian alcohol users (N = 364) were recruited for the study. Participants completed surveys at four waves (spaced 3 months apart), with the first being 7 to 8 weeks after the COVID-19 state of emergency began in Canada. The data were analyzed using a parallel process latent growth class analysis followed by general linear mixed models analysis.

Results: We found evidence for three latent classes: individuals who increased drinking (class 1; n = 23), low-risk drinkers (class 2; n = 311), and individuals who decreased drinking (class 3; n = 30). Participants who increased (vs. those who decreased) problem drinking during the pandemic struggled with increasing levels of social disconnection and were also increasingly more likely to report drinking to cope with these issues. Those in the increasing class (relative to low-risk drinkers) reported increasing levels of depression during the study. Relative to low-risk drinkers, participants in the increasing class had higher pre-pandemic AUDIT scores, greater frequency of solitary drinking, and higher alcohol demand. Interestingly, participants in the decreasing class had the highest pre-pandemic AUDIT scores.

Conclusions: We examined longitudinal data to identify subgroups of drinkers during the pandemic and to identify factors that may have contributed to increased problem drinking. Findings suggest that while most of the sample did not change their alcohol use, a small portion of individuals escalated use, while a small portion decreased their drinking. Identifying the vulnerability factors associated with increased drinking could aid in the development of preventative strategies and intervention approaches.

KEYWORDS
alcohol, COVID-19, longitudinal, problematic drinking, risk factors

INTRODUCTION

The 2019 Coronavirus disease (COVID-19) is a contagious disease characterized by acute to severe respiratory distress among other symptoms (World Health Organization, 2020). The first case was discovered in December 2019 and has since spread resulting in a worldwide pandemic (World Health Organization, 2020). In response to the spread of COVID-19, numerous countries implemented public health measures to mitigate the spread of the virus including the enforcement of lockdowns, mandatory school and workplace closures, and recommendations for social distancing. Although the measures were developed with the intention to reduce the spread of COVID-19 and prevent further fatalities, emerging COVID-19 related research has begun to examine some of the consequences of these measures, including the repercussions of social isolation and the impact of drastic changes to daily life.

As a result of these implemented protective measures, many individuals were unable to participate in activities that would have previously helped to mitigate their feelings of worry and distress, such as accessing gyms, places of worship, and visiting with family and friends. In many cases, individuals were left alone and without various healthy coping options during an immense time of stress, and as a result were found to have higher levels of anxiety, depression, and loneliness (Shield et al., 2021). As such, maladaptive coping mechanisms related to these mental health problems, such as the increased use of alcohol during the pandemic, have become a growing concern (Clay & Parker, 2020; Rehm et al., 2020). Reports of increased alcohol sales, consumption, and problematic use have been noted throughout the course of the pandemic (Capasso et al., 2021; Neill et al., 2020; Wardell et al., 2020) and have, in many cases, been associated with the stress brought on by the COVID-19 pandemic (Avery et al., 2020; Chodkiewicz et al., 2020).

Alcohol use and problems

Data from multiple countries suggests that alcohol consumption have changed throughout the course of the pandemic; however, the findings have been relatively mixed. Some studies have reported no change in alcohol use (Garnett et al., 2021; Schmits & Glowacz, 2021), some have reported decreases in alcohol use (Garnett et al., 2021; Schmits & Glowacz, 2021; Steffen et al., 2021), and some studies have found that alcohol use has increased (Grossman et al., 2020; Pollard et al., 2020; Shield et al., 2021). One study by Kim et al. (2020) conducted in the United Kingdom examined a sample of 182 individuals with a preexisting alcohol use disorder (AUD). The authors found that roughly 24% of the sample reported an increased alcohol intake throughout the pandemic, and of the participants who were classified as abstinent before the pandemic, 17% reported returning to using alcohol (i.e., relapsing) during lockdown (Kim et al., 2020). An important caveat is that many previous studies have specifically examined changes to alcohol consumption (quantity and/or frequency) throughout the pandemic, and have thus left alcohol

problems largely unexamined. Although the amount of alcohol consumption is one facet of problem drinking, diagnoses and treatment often place greater importance on the impairment and distress that alcohol is causing the individual. Therefore, alcohol consumption should be examined in conjunction with alcohol problems for a more well-rounded assessment of the impact of the COVID-19 pandemic on individuals' well-being and functioning. Moreover, when discussing coping or distress pathways, alcohol *problems* are often considered to be central indicators of risk. Those who drink to cope are at risk for problems, irrespective of the level of use (Grant et al., 2009; Kuntsche et al., 2005).

An additional limitation of some emerging COVID-19 and alcohol use-related research is the use of cross-sectional study designs, which offer little insight regarding changes and variability of drinking patterns over the course of the pandemic. In one exception, a study by Minhas et al. (2021) examined participants' alcohol use during the pandemic and matched them to participants' pre-pandemic alcohol use using a linear mixed-effects model. The authors found no significant changes in the number of drinking days, but did, however, find that heavy drinking days and alcohol consequences decreased. While the study by Minhas and colleagues did examine person-centered drinking patterns more closely in their analyses, the authors were only able to utilize two time points: one intrapandemic (June/July 2020) and one pre-pandemic, which varied across participants but was approximately 8 months earlier. Thus, they were unable to provide insight regarding how alcohol consumption patterns changed over the 1-to-2-year course of the pandemic. As a result of these limitations, there is a gap in the literature surrounding alcohol use during the pandemic, whereby studies have not examined person-centered changes in alcohol consumption using multiple, longitudinal time points throughout the course of the pandemic.

Predictors of vulnerability

In times of distress, such as the COVID-19 pandemic, individuals often seek out ways to mitigate and cope with negative feelings. While some individuals select constructive coping mechanisms, others may be motivated to select less adaptive coping mechanisms such as alcohol consumption. Research has begun to elucidate the external stressors and related vulnerability factors that may lead an individual to select alcohol consumption to cope with pandemic distress. One of the first such studies (Wardell et al., 2020) explored various coping-motivated pathways that led to increased alcohol use at the start of the COVID-19 emergency response in Canada (April–May 2020). The authors found that increased depression and social disconnection, living alone, being a parent to a young person under the age of 18 years old, and income loss were associated with greater risk for alcohol problems early in the pandemic (Wardell et al., 2020). Although the study by Wardell and colleagues clearly demonstrates the relationship between coping motives and alcohol use, this study, like many others (Avery et al., 2020; Rodriguez et al.,

2020; Thompson et al., 2021), was cross-sectional and only examined data from the initial stage of the pandemic.

A recent commentary by Rehm et al. (2020) suggested that while alcohol consumption may have decreased in the early stages of the pandemic due to decreased physical and financial availability of alcohol, the later stages of the pandemic may lead individuals to increase their alcohol consumption due to feelings of hopelessness brought on by the pandemic. They argued that based on previous patterns of alcohol use during epidemics and times of economic hardship, some individuals will develop maladaptive coping mechanisms, such as increased alcohol use as a means of self-medication, and that this may have serious long-term effects on individuals and society (Rehm et al., 2020). As such, there is a need to collect and examine longitudinal data to monitor long-term distress pathways that may lead to risky alcohol use, so that individuals at risk can be identified and early interventions can be implemented.

The current study

Of the current pandemic-related research, longitudinal findings are limited, and many studies are based on data collected in existing samples or through cross-sectional study designs. As well, studies have often failed to examine both alcohol use *and* alcohol problems as interrelated, but potentially separable, dimensions of risk. To address the limitations noted in the previously published research, we conducted a four-wave longitudinal study to examine individual differences in problem drinking risk during the COVID-19 pandemic. The first wave of data collection took place within a month of the initial State-of-Emergency in Canada (April 2020) and the subsequent data collection waves were spaced 3 months apart (July 2020, October 2020, and January 2021) allowing us to fully capture changes in participants' alcohol use and related problems within the first 9 months of the pandemic.

Our first goal was to differentiate high- from low-risk subgroups of drinkers during the COVID-19 pandemic using a multiwave longitudinal study. To extend extant literature, we used parallel process latent class growth analyses to model person-centered copatterns of alcohol use and problems. While these analyses were exploratory in nature, we did expect to find at least two subgroups of drinkers: one characterized by increasing alcohol use and/or related problems over time and the other characterized by lower drinking risk (either stable or decreased alcohol consumption). A second major goal of the current study was to report results on the longitudinal follow-up of the baseline sample reported in Wardell et al. (2020) and examine how high- and low-risk subgroups of drinkers differed on coping-related factors over time. We expected high-risk drinkers to experience escalating depression, social disconnectedness, and coping motives for drinking during the first 9 months of the COVID-19 pandemic. Consistent with this work by Wardell et al. (2020) and Minhas et al. (2021), we expected pre-pandemic alcohol vulnerability factors measured at baseline (namely AUD risk level, frequency of solitary drinking, and greater alcohol demand) to increase the likelihood of being a high-risk drinker over time during the pandemic. Finally, consistent with Wardell et al. (2020), we expected that three socio-demographic factors would relate to being a high-risk drinker over time during COVID-19, namely being a parent living with a young person under the age of 18, experiencing a COVID-19 income loss, and living alone.

MATERIALS AND METHODS

Participants and procedure

A detailed description of sample recruitment and methodology can be found in a previous publication using baseline data from this study (see Wardell et al., 2020). Participants for the study were recruited through Prolific, an online crowdsourcing platform on which individuals can access and complete surveys and studies run by researchers (Palan & Schitter, 2018). Online crowdsourcing has become an increasingly popular method of data collection in the addiction literature, and previous studies have also shown that online crowdsourcing has produced valid and reliable data, especially in the case of alcohol use (see Kim & Hodgins, 2017). The sample of the current study was comprised of adults living in Canada who identified as alcohol users and who had a high approval rating for previous surveys completed on Prolific (average approval rating for this sample: 99.4%). Participants completed four waves of online surveys. Data collection for wave one occurred between April 30, 2020 and May 4, 2020, approximately 7 to 8 weeks after the COVID-19 state of emergency was declared in Canada. Data collection for wave two occurred in July 2020, wave three occurred in October 2020, and data for the final assessment wave were collected in January 2021. All participants were given $13 CAD as compensation at all data collection waves. This study was approved by our institutional research ethics board.

Four attention check items, as recommended by Prolific's guidelines, were implemented in this study to ensure data quality (e.g., "Please answer this question by choosing option number two, "disagree"; Marjanovic et al., 2014; Prolific Team, 2020). Participants' data were automatically excluded from the study if they failed two or more attention checks or completed all questions in an unrealistically short time (defined as under 20 min in this study; $n = 2$). Of the 400 remaining participants, we selected a subsample that endorsed drinking any alcohol in the previous 3 months prior to the baseline survey ($n = 364$; $M_{age} = 32.16$ years, $SD_{age} = 9.20$ years; 54.7% male). About half of the sample lived in Ontario (51.60%) and many participants self-identified as White (65.70%). Most of the sample was non-student (75.80%), with a median self-reported income of $80,000 to $99,000. Approximately 41.20% of participants reported a COVID-19-related income loss; 20.30% of participants reported being a parent living with at least one child (under 18 years of age); and 12.90% endorsed yes to living alone during the pandemic. Of the original sample, $n = 294$ completed wave two; $n = 262$ completed wave three; and $n = 246$ completed wave four.

Measures

Quantity and frequency of alcohol use

Alcohol use was represented by the product of two items from the Recommended Alcohol Questions developed by the NIAAA (National Institute on Alcohol Abuse & Alcoholism, 2003). The first item assessed the frequency of alcohol use in the past 30 days ("How often did you usually have any kind of drink containing alcohol?") and responses ranged from 0 = *Never* to 7 = *Every day*. The second item assessed the quantity of alcohol consumed on a typical drinking day in the past 30 days ("How many alcoholic drinks did you have on a typical day when you drank alcohol") and responses ranged from 1 = *1 drink* to 10 = *25 or more drinks*.

Alcohol problems

Consequences of alcohol use in the past 30 days were assessed with the Short Inventory of Problems—Revised (SIP-R; Kiluk et al., 2013). Participants were presented with 15 alcohol-related problems in several domains (e.g., "I have been unhappy because of my drinking or drug use"). Items were rated on a 4-point Likert scale ranging from 0 = *Never* to 3 = *Daily or almost daily* and a sum score was calculated for each participant. Cronbach's alpha for the current sample ranged from $\alpha = 0.701$ to 0.941 across the four assessment waves.

Coping motives for alcohol use

The Drinking Motive Questionnaire-Revised Short Form (Kuntsche & Kuntsche, 2009) assessed self-reported motivation for drinking at each assessment wave. Participants responded using a 3-point Likert scale (1 = *Never* to 3 = *Always*) based on how frequently in the past month (30 days) their drinking was motivated by each of the items (e.g., "How often do you drink because you like the feeling?"). The three-item subscale assessing for coping motives was used for the current study. Higher mean scores reflect the greater endorsement of coping motives for drinking. Cronbach's alpha for the coping motives subscale ranged from $\alpha = 0.834$ to 0.862 across the assessment waves.

Depressive symptoms

The severity of depressive symptoms was assessed using the nine-item Patient Health Questionnaire (PHQ-9; Kroenke et al., 2001) at each assessment wave. Participants indicated how often they had been bothered by various depressive symptoms (e.g., feeling down, depressed, or hopeless) over the past 30 days and responses ranged from 0 = *Not at all* to 3 = *Nearly every day*. Higher sum scores reflect greater levels of depressive symptoms. Cronbach's alpha for the current sample ranged from $\alpha = 0.865$ to 0.899 across the four assessment waves.

Social connectedness

Participants completed the Social Connectedness Scale-Revised (SCS-R; Lee et al., 2001) at each assessment wave. The SCS-R has 20-items and higher sum scores reflect stronger feelings of being socially connected to others. The scale includes statements such as: "I don't feel related to anyone." Responses ranged from 1 = *Strongly disagree* to 6 = *Strongly agree*. Cronbach's alpha for the current sample ranged from $\alpha = 0.928$ to 0.942 across the four assessment waves.

Sociodemographic factors

Consistent with the findings from Wardell et al. (2020), we included three relevant sociodemographic factors: living alone (0 = *No*, 1 = *Yes*), being a parent living with a young person under the age of 18 (0 = *No*, 1 = *Yes*), and experiencing an income loss during the pandemic (0 = *No*, 1 = *Yes*).

Hazardous alcohol use

The AUD Identification Test (AUDIT; Saunders et al., 1993) is a 10-item measure screening for AUD symptoms. The AUDIT was given to participants at baseline to assess risk for AUD in the 12-months *before* the start of the pandemic. Items, such as "How often do you have six or more drinks on one occasion," are rated on a scale from 0 to 4, with the wording of responses varying between items but higher values represent a greater risk for AUD. A sum score was calculated for each participant. Cronbach's alpha for the current sample was $\alpha = 0.83$ at the baseline assessment wave.

Alcohol demand

The Alcohol Purchase Task (APT; Murphy & MacKillop, 2006) was administered to measure individual behavioral economic demand for alcohol in the 30-days prior to the COVID-19 state of emergency (retrospectively reported at baseline). The APT asked participants to imagine a typical day on which they would drink from 9 p.m. to 2 a.m. and indicate how many standard drinks they would purchase at various prices. Participants were instructed that these hypothetical drinks must be consumed within this 5-h period, that they must assume they did not use alcohol or drugs earlier, and that alcohol is only obtainable from this source. Participants indicated their desired use at escalating levels of cost ranging from $0 to $15.

The APT data were screened for missing data ($n = 8$) and nonsystematic responses based on well-established criteria ($n = 37$; Amlung

et al., 2015; Stein et al., 2015). Demand indices were calculated (see Hursh & Silberberg, 2008; Murphy & MacKillop, 2006) and two overall facets of demand were obtained using standardized scores, consistent with work examining the latent structure of hypothetical purchase tasks (Aston et al., 2017; Bidwell et al., 2012): *Amplitude*, reflecting consumption at unrestrained cost and *Persistence*, reflecting sensitivity to increasing cost.

Solitary drinking

Participants indicated the proportion of time they spent drinking alone versus with other people in the 30 days prior to the COVID-19 emergency (retrospectively reported at baseline). Participants used a scale ranging from 0 = *100% by yourself* to 10 = *100% with other people*. Responses were reverse coded so that higher values reflected greater solitary drinking. The definition of "socializing with other people" in the measure included both in-person and virtual socializing to avoid participant confusion.

Data analysis overview

Prior to substantive analyses, data were screened, and outliers were replaced with the highest acceptable value within ±3.29 SD. Less than 1% of the data were outlying values. A series of independent *t*-tests were then conducted to examine potential baseline differences among participants with complete (*n* = 246; coded as 1) versus incomplete (*n* = 118; coded as 0) data across the four assessment waves. Next, a parallel process latent class growth model was run to extract meaningful subgroups of drinkers over the first 9 months of the pandemic. This analysis is a person-centered approach that allowed us to identify latent (or unobserved) subgroups based on their copattern of alcohol use and related problems overtime during the pandemic (Muthen & Muthen, 2000). We included linear and quadratic growth terms in the main parallel process latent class growth model. It was important to allow for nonlinear change because, in Canada, the public health guidelines to curb the spread of COVID-19 have been dynamic across time and region. For example, early in the pandemic, all provinces were in a state of emergency—meaning that all nonessential public spaces (e.g., restaurants and bars) were closed and people were encouraged to stay at home. As the pandemic unfolded, some restrictions were temporarily relaxed (e.g., restaurants could open for outdoor dining), but were later reimplemented to manage the viral load. Therefore, the influence of closures and reopenings was expected to result in nonlinear effects of time on problem drinking and related correlates (e.g., depression) in this study. While the alcohol problems variables were below established cutoffs for skew (<3.0) and kurtosis (<8.0) for behavioral data (Kline, 2011), we opted to estimate the main growth model using the robust maximum likelihood estimator to account for slight nonnormality (Muthén & Asparouhov, 2012). Consistent with best practice guidelines, we examined growth models with one through six

classes and evaluated fit (in part) using several indices, including the sample size-adjusted Bayesian Information Criterion (SA-BIC), entropy, and the bootstrapped parametric likelihood ratio test (Jung & Wickrama, 2007). The SA-BIC is a relative fit index and lower values indicate better fit (with a difference of 10 points indicating superior fit; Raftery, 1995). Entropy is a measure of classification quality and values of 0.80 or greater are considered good (Ram & Grimm, 2009). Finally, the bootstrapped parametric likelihood ratio test indicates if a model with *k* classes is statistically significantly better than a model with *k* − 1 classes (Nylund et al., 2007). In addition to fit statistics and being consistent with published work on the extant literature (Williams & Kibowski, 2016), we visually inspected all models to examine the distinctiveness and theoretical meaningfulness of the subgroups. Visual inspection was done by plotting the cotrajectories of use and problems for each class for models with one through six classes. We were also careful not to overfit any given model (indicted by class sizes less than 5% of the total sample size).

Following the parallel process latent growth class analysis, we conducted generalized linear mixed models (GLMMs) to examine differences between the drinking subgroups on coping-related variables across assessment waves (depression, social connectedness, and coping motives for drinking). Dummy coded variables were used to represent the subgrouping variable and were used to create interaction terms with time. Age, sex, and race (White vs. non-White) were added as covariates (grand-mean centered) in all GLMMs. All GLMMs were run specifying random intercepts and slopes. As in the parallel process latent class growth model, we modeled both linear and quadratic effects of time (as well as their interactions with class). Finally, we ran multinomial logistic regressions to examine the effects of baseline sociodemographic (i.e., living alone, being a parent living with a young person under the age of 18, and losing income during COVID-19) and pre-COVID alcohol vulnerability factors (i.e., past 12-month AUDIT scores, past 30-day amplitude and persistence facets of alcohol demand, and past 30-day solitary drinking frequency) on drinking class membership. A 95% confidence interval approach was used to interpret the odds ratios for effects in this model (Table 1).

RESULTS

Parallel process latent growth class analysis

See Table 2 for the fit information for models with one to six classes. The SA-BIC index declined progressively across models and the entropy values were all well above 0.80, suggesting good overall classification quality. The bootstrapped parametric likelihood ratio test was significant for all models. Models with more than three classes had class sizes that were very small (<2% of the sample size). This was associated with very low classification probabilities (<0.48), indicating that models with more than three classes were not correctly classifying participants in these smaller groups. We also visually inspected all class solutions (by plotting

TABLE 1 Descriptive statistics for key variables across assessment waves

Variable	Mean	SD	Skewness	Kurtosis	Range
Short inventory of problems-revised					
Wave 1 (*n* = 364)	3.14	4.75	1.91	2.94	0 to 19.00
Wave 2 (*n* = 294)	2.05	4.23	2.84	7.81	0 to 19.00
Wave 3 (*n* = 262)	2.26	4.75	2.58	6.00	0 to 20.00
Wave 4 (*n* = 246)	1.72	3.51	2.77	7.50	0 to 15.00
Quantity and frequency of alcohol use					
Wave 1 (*n* = 364)	7.34	7.70	1.80	4.15	0 to 47.53
Wave 2 (*n* = 294)	8.49	8.84	2.05	5.08	0 to 47.50
Wave 3 (*n* = 262)	7.27	8.17	1.97	4.64	0 to 47.10
Wave 4 (*n* = 246)	6.06	6.78	1.84	4.22	0 to 39.66
Social connectedness scale-revised					
Wave 1 (*n* = 364)	79.23	16.92	−0.11	−0.72	37.00 to 119.00
Wave 2 (*n* = 294)	77.53	16.97	−0.05	−0.58	33.00 to 116.00
Wave 3 (*n* = 262)	77.15	17.87	−0.07	−0.49	30.00 to 117.00
Wave 4 (*n* = 246)	76.18	18.04	−0.08	−0.44	30.00 to 118.00
Patient Health Questionnaire (PHQ-9)					
Wave 1 (*n* = 364)	7.51	5.20	0.75	0.42	0 to 24.64
Wave 2 (*n* = 294)	7.58	5.27	0.87	0.49	0 to 25.07
Wave 3 (*n* = 262)	7.77	5.54	0.81	0.35	0 to 26.09
Wave 4 (*n* = 246)	8.10	5.72	0.74	0.16	0 to 27.00
The Drinking Motive Questionnaire-Revised Short Form—Coping Motives					
Wave 1 (*n* = 364)	1.51	0.55	0.92	0.18	1 to 3.00
Wave 2 (*n* = 294)	1.53	0.54	0.80	−0.09	1 to 3.00
Wave 3 (*n* = 262)	1.56	0.56	0.84	0.14	1 to 3.00
Wave 4 (*n* = 246)	1.57	0.56	0.84	−0.05	1 to 3.00

TABLE 2 Fit information for the parallel process latent growth class analysis

Class #	SABIC	Entropy	Smallest class size (%)	Parametric BLRT *p*-value
1	11978.47	NA	NA	N/A
2	11640.42	0.97	7.60	<0.001
3	**11497.59**	**0.95**	**6.31**	**<0.001**
4	11393.93	0.95	1.30	<0.001
5	11303.73	0.95	3.00	<0.001
6	11217.93	0.96	1.30	<0.001

Note: The retained model fit information is bolded.

the cotrajectories for each class in all models) and determined that the three-class solution was the most interpretable. In addition to having small class sizes and low classification probabilities, models with more than three classes had subgroups that overlapped substantially in their copatterns of alcohol use and problems across the four assessment waves (i.e., they were not meaningfully unique). Therefore, after considering all information, we opted to retain the three-class solution.

The first class (*n* = 23; 6.31% of the sample) was characterized by high initial levels of both alcohol use and problems (see Table 3; Figure 1). In this class, alcohol use increased across waves in a linear fashion, whereas problems increased quadratically—steadily increasing until the third wave and then plateauing. The second and largest class (*n* = 311; 85.45% of the sample) were defined by low initial levels of alcohol use. In this class, alcohol use changed in a quadratic manner, with mild nonproblematic increases in alcohol use until the third wave and then declining. Alcohol problems in this class declined quadratically across the assessment waves. The third class (*n* = 30; 8.24% of the sample) was characterized by high initial levels of both alcohol use and problems. In this class, alcohol use changed quadratically—increasing initially from waves 1 to 2 but declining thereafter. Alcohol problems also changed quadratically, showing steep declines from wave to wave. In subsequent sections of this study, we refer to the classes as follows: *increasers* (class 1), *low-risk drinkers* (class 2), and *decreasers* (class 3).

Generalized linear mixed models

Three separate GLMMs were conducted. Initially, all models were run with both linear and quadratic effects of time (as well as the

TABLE 3 Parameter estimates for parallel process latent class growth analysis

Class	Alcohol use (Q × F)	Alcohol problems (SIP)
1—Increasers (n = 23)		
Intercept	**14.48** (p < 0.001)	**11.97** (p < 0.001)
95% CI	[11.35, 17.62]	[10.73, 13.21]
Linear slope	**4.04** (p = 0.036)	**3.31** (p < 0.001)
95% CI	[0.26, 7.83]	[1.55, 5.07]
Quadratic slope	−1.06 (p = 0.095)	**−0.68** (p = 0.011)
95% CI	[−2.31, 0.19]	[−1.21, −0.15]
2—Low risk drinkers (n = 311)		
Intercept	**6.64** (p < 0.001)	**1.42** (p < 0.001)
95% CI	[5.80, 7.48]	[1.09, 1.75]
Linear slope	**1.12** (p = 0.035)	**−0.78** (p = 0.001)
95% CI	[0.08, 2.15]	[−1.24, −0.32]
Quadratic slope	**−0.40** (p = 0.018)	**0.19** (p = 0.007)
95% CI	[−0.74, −0.07]	[0.05, 0.33]
3—Decreasers (n = 30)		
Intercept	**15.47** (p < 0.001)	**11.89** (p < 0.001)
95% CI	[12.48, 18.46]	[10.69, 13.10]
Linear slope	**5.44** (p = 0.001)	**−5.20** (p < 0.001)
95% CI	[2.18, 8.70]	[−6.85, −3.55]
Quadratic slope	**−2.37** (p < 0.001)	**0.75** (p = 0.002)
95% CI	[−3.42, −1.32]	[0.27, 1.23]

Note: Statistically significant (p < 0.05) parameters are bold.

linear time by class, and the quadratic time by class interaction terms). However, in all models, there were no main effects of the quadratic time variable nor were there supported quadratic interaction effects. Therefore, we removed the quadratic terms from the models for parsimony and to simplify the interpretation of the linear time trends (see Table 4; Figure 2). In the first model, there was a supported drinking class (increasers vs. decreasers) by time interaction in predicting social connectedness, after controlling for sex, age, and race. Simple slopes analysis indicated that increasers had a statistically significant decline in their social connectedness over time (B = −2.63, SE = 0.92, p = 0.005), whereas the level of social connectedness was stable for decreasers (B = 0.09, SE = 0.73, p = 0.90). Level of social connectedness also did not significantly change among low-risk drinkers (B = −0.70, SE = 0.64, p = 0.38) (see Figure 2A). In the second model, there was a supported drinking class (increasers vs. low-risk drinkers) by time interaction and follow up simple slope analyses showed that increasers reported escalating depressive symptoms over the first 9 months of the pandemic (B = 1.18, SE = 0.37, p < 0.01; see Table 4; Figure 2B), but this effect was not found among low-risk drinkers (B = 0.09, SE = 0.09, p = 0.28). Depressive symptoms in the decreaser subgroup also did not change over time (B = 0.36, SE = 0.29, p = 0.22). The third and final GLMM supported a meaningful drinking class (increasers vs. decreasers) by time interaction in the prediction of coping motives for alcohol use

(See Table 4). Simple slopes analyses demonstrated that increasers (B = 0.09, SE = 0.04, p = 0.04), but not decreasers (B = −0.03, SE = 0.03, p = 0.29) reported elevated coping motives for alcohol use over time (see Figure 2C). Low-risk drinkers showed no change in coping motives over time (B = 0.016, SE = 0.01, p = 0.16). Overall, the findings across the main GLMMs demonstrate that participants who increased in their alcohol use and related problems during the pandemic were struggling with increasing levels of depression and social disconnection over time and were increasingly likely to report drinking to cope with these issues over time.

Multinomial logistic regression

Multinomial logistic regression were conducted to examine the influence of sociodemographic and baseline alcohol vulnerability factors on drinking class membership. As seen in Table 5, having higher AUDIT scores (in the 12 months prior to COVID), reporting a greater frequency of solitary drinking (in the 30 days prior to COVID), and being higher in the amplitude facet of alcohol demand (in the 30 days prior to COVID) related to greater odds of being in the increaser drinking class (relative to being in the low-risk class). Higher past-year AUDIT scores related to increased risk for being in the decreasing class compared to both lower-risk and the increasing drinking classes. Contrary to hypotheses, living alone, being a parent living with a young person under the age of 18, and reporting a pandemic income loss did not relate to drinking class membership.

DISCUSSION

The current study aimed to examine longitudinal data to identify whether meaningful subgroups of drinkers would emerge over the course of the pandemic and to identify whether any factors may have contributed to increased drinking and alcohol-related problems among some people. We conducted a parallel process latent class growth analysis and identified three subgroups of drinkers based on their copattern of alcohol use and problems during the first 9 months of the pandemic: a low-risk normative class, an increasing class, and a decreasing class.

A notable strength of the current study is the novel methodological and statistical approach that was applied to examine the data. To date, very few studies have modeled person-centered changes in alcohol use over extended periods of time throughout the COVID-19 pandemic. Additionally, previous studies have often defined the risk of increased drinking solely regarding alcohol use variables (i.e., quantity and frequency), whereas the current study considered variability in both alcohol use and alcohol-related problems over time. In doing so, we found that the decreasing group demonstrated a steep decline in alcohol problems, but that their level of alcohol use initially increased before tapering off. This finding may indicate that these individuals initially began consuming more alcohol in response to the stress brought on by the onset of the pandemic but later may have
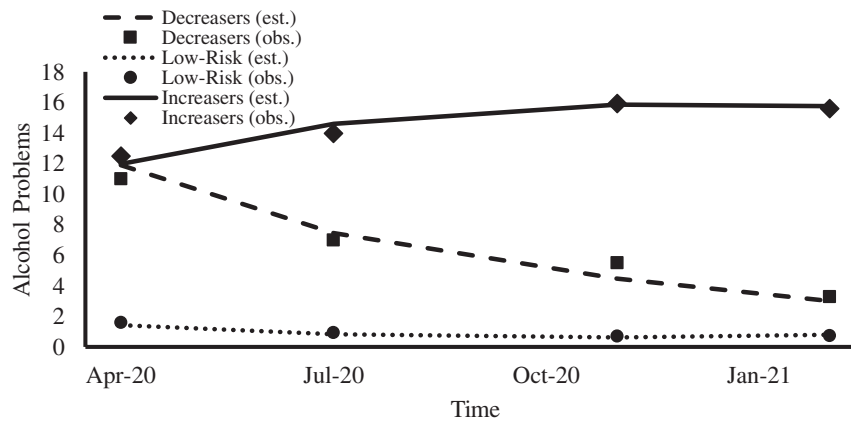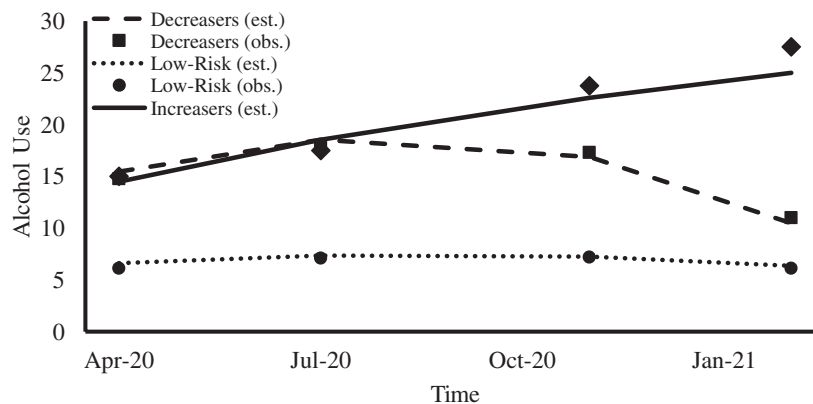
Alcohol Problems

Alcohol Use

FIGURE 1 Alcohol problems. Alcohol use

exercised particular coping mechanisms or healthy alternatives that lead to their decrease in alcohol use and problems. Another explanation may be that decreasers initially increased their alcohol consumption due to a slight reduction in responsibilities (e.g., not needing to go to work or wake up early) coupled with a sense of boredom (e.g., stay at home orders and social distancing). Likewise, this may have been an initial reaction to the pandemic and the lockdowns, but the decreasing group may have recognized that their behaviors were not sustainable and thus began to decrease their alcohol consumption after the second assessment wave. Had the current study chosen to examine either of these alcohol variables in isolation, we may not have been able to gather an accurate view of the nuances that occurred within the decreasing group over the course of the pandemic.

An additional strength of the current study is that our findings parallel those of previously published COVID-19 and alcohol use studies (although using different methodological and statistical methods), such that three subsets of individuals are often identified: those who increase their use, those who decrease their use, and those who maintain/do not change their use (Garnett et al., 2021;

Grossman et al., 2020; Pollard et al., 2020; Schmits & Glowacz, 2021). Findings of the current study revealed that approximately 6% of our sample increased their alcohol use and problems, 86% remained stable, and 8% decreased their alcohol use and problems. Our findings are consistent with those reported in previous studies and also contribute to the basic understanding of how alcohol use has changed during the COVID-19 pandemic in Canada.

Speaking to the findings from our GLMMs and the possible risk factors we examined, we found that our increasing group displayed a decrease in social connectedness, an increase in depression, and an increase in coping motives for drinking in comparison to our other two groups who remained relatively stable across these factors. These findings reflect the predictions made in the review by Rehm et al. (2020), in which the authors explained that based on an examination of previous pandemics, the later stages of COVID-19 would likely result in increased alcohol consumption for individuals struggling with distress and feelings of hopelessness. Previously published baseline results from the current sample (Wardell et al., 2020) found greater depression and lower social connectedness

TABLE 4 Summary of the generalized linear mixed models

| Predictors	B	SE	t	p-value
Outcome: social connectedness				
Intercept	73.91	3.69	19.98	<0.001
Time (coded as 0, 1, 2, and 3)	−2.62	0.92	−2.84	0.01
Age	−0.01	0.09	−0.07	0.94
Sex (male = 1, female = 0; centered)	1.69	1.75	0.96	0.34
Race (White = 1; Non-White = 0; centered)	−0.04	1.86	−0.02	0.98
D1 (increasers = 0; low risk = 1)	6.30	3.82	1.64	0.10
D2 (increasers = 0; decreasers = 1)	−4.69	4.84	−0.97	0.33
Time*D1	1.92	1.25	1.54	0.12
Time*D2	2.72	1.17	2.31	0.02
Outcome: coping motives				
Intercept	1.97	0.10	19.42	<0.001
Time (coded as 0, 1, 2, and 3)	0.09	0.04	2.07	0.04
Age	<0.01	<0.01	−0.56	0.58
Sex (male = 1, female = 0; centered)	−0.09	0.04	−1.99	0.05
Race (White = 1; Non-White = 0; centered)	<0.01	0.05	0.05	0.96
D1 (increasers = 0; low risk = 1)	−0.56	0.10	−5.36	<0.001
D2 (increasers = 0; decreasers = 1)	0.13	0.13	0.98	0.33
Time*D1	−0.07	0.08	−1.65	0.10
Time*D2	−0.13	0.05	−2.28	0.023
Outcome: depressive symptoms				
Intercept	12.48	1.02	12.16	<0.001
Time (coded as 0, 1, 2, and 3)	1.18	0.37	3.19	<0.01
Age	−0.08	0.03	−3.24	0.001
Sex (male = 1, female = 0; centered)	−1.66	0.47	−3.55	<0.001
Race (White = 1; Non-White = 0; centered)	−0.08	0.49	−0.15	0.88
D1 (increasers = 0; low risk = 1)	−5.55	1.06	−5.23	<0.001
D2 (increasers = 0; decreasers = 1)	−3.37	1.34	−2.50	0.01
Time*D1	−1.08	0.38	−2.84	<0.01
Time*D2	−0.82	0.47	−1.72	0.09

Note: Age, sex, and race were added as covariates to all models and were grand-mean centered prior to running the analyses.

was associated with increased alcohol consumption during the first month of the COVID-19 pandemic. The current analysis extends this research by examining these factors longitudinally during the extended period of time when pandemic restrictions have interfered with what was previously considered to be "normal life." Given the chronic nature of the pandemic, results of the current study suggest that a subset of individuals have worsened with respect to alcohol use and problems, which is associated longitudinally with increased loneliness, depression, and coping-related drinking motives. Findings from the current longitudinal study also suggest that COVID-related increases in alcohol use appear to be more related to internal stressors (loneliness, depression, and social connection) than external factors (living alone, income loss, and being a parent living with a young person under the age of 18) as was found in previous, but shorter-term, studies (Wardell et al., 2020).

Finally, with respect to alcohol factors that were found to be prospectively related to increased alcohol consumption during the pandemic, the current study examined individuals' pre-pandemic levels of alcohol use and found that greater frequency of drinking, having higher scores on the AUDIT, and having a higher amplitude with respect to one's alcohol demand, were all significant predictors of being in the increasing group (relative to the low-risk group). These findings are in line with previously published literature demonstrating that pre-pandemic alcohol use and pre-to-early pandemic AUD symptoms are related to worsening drinking during COVID-19 (Chodkiewicz et al., 2020; Wardell et al., 2020).

Despite being able to identify four specific predictors of vulnerability to alcohol consumption, some of our chosen predictors were not found to be significantly associated with increased alcohol use and problems. Specifically, living alone, having a reduced income, being a parent living with a young person under the age of 18, and alcohol

(A) *Social Connectedness*
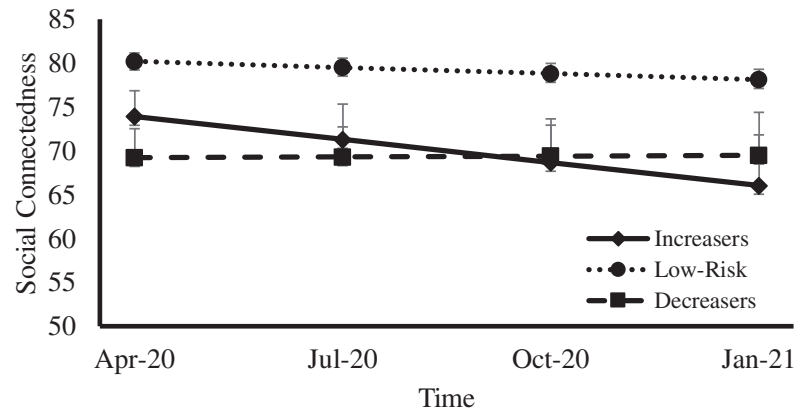
(B) *Depression Symptoms*
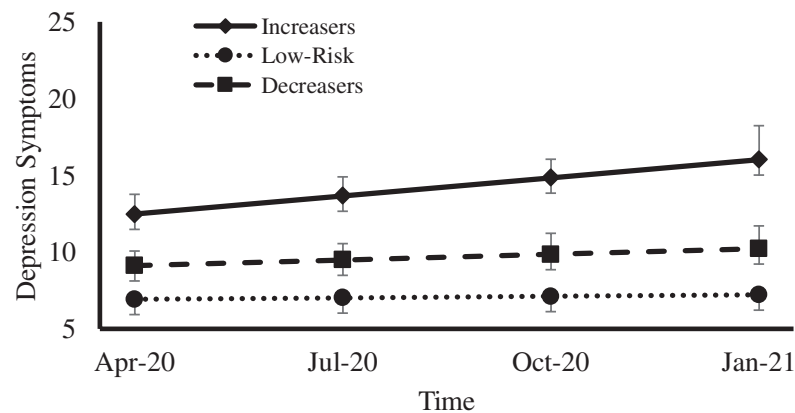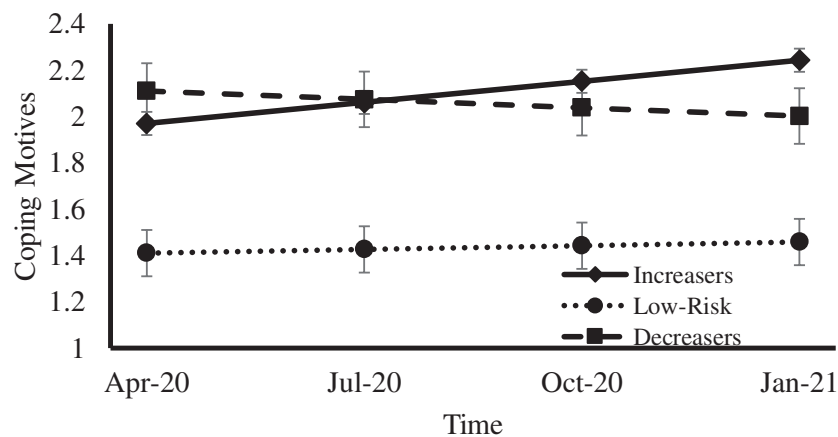

(C) *Coping Motives*

FIGURE 2 A, Social connectedness, B, depression symptoms, C, coping motives

demand Persistence was not found to be significant, which is contrary to some earlier COVID-related research (Capasso et al., 2021; Neill et al., 2020; Wardell et al., 2020). One possible explanation for this discrepancy between our findings and those of other COVID-related studies is that the current study employed a longitudinal design whereas many other studies have been cross-sectional. As such, these initial stressors may have been most relevant to immediate increases in drinking early in the pandemic but may have become less relevant when examining changes in drinking over time. Future studies should seek to assess, specifically, how individuals adapted to these factors over the course of the pandemic, and how they may or may not have continued to contribute to individuals' difficulties coping

TABLE 5 Summary of multinomial logistic regression models

Baseline predictors	B	SE	p value	OR	95% CI (OR)
Increasers (vs. low risk)					
Living alone	−0.38	0.92	0.68	0.68	0.11 to 4.18
Income decrease	0.26	0.59	0.66	1.30	0.41 to 4.10
Parent (child under 18 years)	−0.23	0.78	0.77	0.79	0.17 to 3.64
Persistence	−0.42	0.49	0.39	0.66	0.25 to 1.71
Amplitude	0.73	0.34	0.03	2.08	1.07 to 4.04
AUDIT	0.22	0.06	<.001	1.25	1.10 to 1.40
Solitary drinking	0.25	0.09	0.01	1.29	1.08 to 1.53
Age	−0.01	0.03	0.79	0.99	0.93 to 1.06
Sex (male = 1, female = 0)	−0.52	0.60	0.38	0.59	0.18 to 1.90
Race (White = 1; Non-White = 0)	0.69	0.65	0.28	2.00	0.57 to 7.09
Decreasers (vs. low risk)					
Living alone	0.41	0.81	0.61	1.51	0.31 to 7.36
Income decrease	−0.24	0.58	0.68	0.79	0.25 to 2.44
Parent (child under 18 years)	−0.09	0.79	0.91	0.92	0.19 to 4.33
Persistence	−0.65	0.49	0.19	0.52	0.20 to 1.37
Amplitude	0.25	0.38	0.51	1.29	0.61 to 2.72
AUDIT	0.35	0.06	<.001	1.42	1.26 to 1.61
Solitary drinking	0.15	0.08	0.08	1.16	0.98 to 1.36
Age	−0.01	0.03	0.84	0.99	0.94 to 1.06
Sex (male = 1, female = 0)	−0.15	0.59	0.80	0.86	0.27 to 2.74
Race (White = 1; Non-White = 0)	0.69	0.66	0.30	1.99	0.54 to 7.30
Increasers (vs. decreasers)					
Living alone	−0.79	1.05	0.57	0.45	0.06 to 3.53
Income decrease	0.50	0.70	0.47	1.65	0.42 to 6.48
Parent (child under 18 years)	−0.15	0.96	0.88	0.87	0.13 to 5.66
Persistence	0.23	0.60	0.70	1.26	0.36 to 4.11
Amplitude	0.48	0.42	0.25	1.61	0.72 to 4.64
AUDIT	−0.13	0.07	0.046	0.88	0.767 to 0.998
Solitary drinking	0.02	0.10	0.31	1.11	0.91 to 1.37
Age	0.00	0.04	0.95	1.00	0.93 to 1.07
Sex (male = 1, female = 0)	−0.37	0.70	0.59	0.69	0.18 to 2.70
Race (White = 1; Non-White = 0)	0.01	0.79	0.99	1.008	0.22 to 4.73

Although the current study had a variety of strengths such as a longitudinal design, a large sample size from across Canada, and multiple waves of assessment, including one within the first 60 days of Canada's pandemic emergency response, the present study is not without its limitations. First, the study collected self-report data through an online platform (i.e., Prolific) and asked participants to retrospectively recall pre-pandemic behaviors after the pandemic began. In an attempt to collect the most accurate data possible, we implemented a variety of criteria such as attention checks, the use of well-validated measures, and the use of measures (e.g., APT) that have previously been shown to produce similar online and in-person results (Morris et al., 2017). Second, we recognize a lack of diversity and representation among our participants. Our sample was characterized by high socioeconomic status and was predominantly from Ontario, British Columbia, and Quebec. Although these three provinces make up roughly 75% of Canada's entire population (Statistics Canada, 2019), we acknowledge that there is underrepresentation from the other nine provinces and territories among our sample. Third, we recognize that we conducted our study in a subclinical sample (i.e., those without a diagnosed AUD). While our work has general implications for understanding problem drinking risk during the pandemic, we cannot necessarily extrapolate these findings to AUD populations. Fourth, while our sample size was reasonably large in absolute terms, it could be considered modest for conducting class analyses. Therefore, our selection of the class model to retain was based largely on visual inspection of the data,

as well as by practical guidelines (i.e., no class size falling below 5% of the sample). It will be important for future studies on pandemic-related drinking to replicate our class solution in larger, representative samples of drinkers. A related limitation of our study was the 32% overall attrition rate across waves. While this overall rate is consistent with some longitudinal research in the field, the attrition may have lowered statistical power in analyses involving our smaller classes (i.e., increasers and decreasers). Again, it will be important for future research on COVID-19-related drinking habits to replicate our findings in larger samples with lower attrition rates. Despite the above limitations, this study provides initial evidence for heterogenous drinking patterns during the COVID-19 pandemic and for the factors that differentiate high- from low-risk alcohol users.

In sum, this study aimed to capture empirical heterogeneity in the trajectories of alcohol use and related problems during the COVID-19 pandemic. Future work should further examine individuals who decreased in their risk for heavy drinking and related problems throughout the pandemic, as this may provide insight regarding their methods of coping and managing pandemic-related distress. As for those in the high-risk group, future research may seek to examine exactly which aspects of the pandemic (e.g., increased isolation, fear of illness, financial stressors, etc.) were most distressing so that interventions and treatments can be tailored accordingly. Cognitive behavioral therapy may be helpful for these individuals as it has shown to be effective for risky drinking, as well as for its emotional correlates (e.g., depression; Brown et al., 1997; Riper et al., 2014). Finally, additional longer-term longitudinal studies are necessary for understanding how the COVID-19 pandemic has continued to impact individuals (beyond the assessment waves examined in this study) and will be especially necessary when considering and examining long-term and residual effects.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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