Knowledge Synthesis

Alcohol consumption and the COVID-19 pandemic: synthesizing knowledge for policy action

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Key Messages

Compared to before the COVID-19 pandemic, 6.1% of all survey participants reported drinking much less alcohol, 5.7% reported drinking slightly less alcohol, 18.5% reported drinking slightly more alcohol, 4.8% reported drinking much more alcohol, and 65.0% indicated no change in their consumption since the start of the pandemic.

Multivariate analyses indicate that changes in alcohol use since the start of the pandemic are associated with age, household income, a person's living situation, anxiety, and feeling lonely or depressed. In particular, people with mild to moderate and severe anxiety had greater odds of increasing their alcohol consumption as compared to people with no to low levels of anxiety.

Key Words: Alcohol; Heavy Episodic Drinking; Policy; COVID-19; Financial crisis; Anxiety; Depression; Social isolation; Systematic review; Survey

Report Table of Contents

1.1 Research issue **5**
1.2 Aims of the knowledge synthesis **6**
2.2 Knowledge Synthesis Project #2: Secondary analysis of data sources to assess changes in alcohol consumption **10**
2.2.1 Paper 1: The impact of COVID-19 on alcohol consumption in Canada - Secondary analysis of survey data 10
2.2.2 Validation of the survey data analysis using per capita consumption data 33
2.2.3 Comparison of survey data analysis with data from a European study 34
2.3 Knowledge Synthesis Project #3: Expert interviews to discuss triangulating the evidence and policy recommendations **34**
3.1 Knowledge Synthesis and Mobilization Activities **35**
4.1 Findings of the knowledge synthesis **37**
4.2 Implications of this knowledge synthesis **38**

1.1 Research issue

Health researchers are warning that alcohol use has increased due to the COVID-19 pandemic which is likely to have immediate and long term public health consequences; however, while a few ad-hoc reports from North America show increases in alcohol sales,[1-3] scientific evidence on this topic is sparse and there is no coordinated policy effort to address this brewing crisis.[4] The COVID-19 pandemic potentially has multiple, countervailing effects on alcohol use. For example, social isolation, anxiety, layoffs, and financial distress experienced as a result of the pandemic may lead to increased consumption.[5,6] A blurring of work and leisure hours and popularization of cocktail hour during the lockdown may lead to increased consumption.[7] In contrast, decreased availability of alcohol and diminished financial resources may lead to a decrease in consumption.[8] Further, a shift from on-premise to off-premise drinking may result in a shift from alcohol-related public disturbances to higher levels of domestic violence.[9]

Alcohol policy, especially restrictions on sales during the current pandemic, has become a topic of public debate. There have been discussions about closing alcohol outlets or restricting alcohol sales; however, arguments against these measures include possible increases in emergency department (ED) visits due to alcohol withdrawal.[10] Indeed, the World Health Organization (WHO) has recommended restrictions on alcohol sales to slow the spread of COVID-19.[11] These policies may also affect levels of domestic violence. Countries which have restricted alcohol sales entirely, such as South Africa, have reported a reduction in trauma cases arriving at EDs.[12] In contrast, in countries where alcohol sales have not been restricted (e.g., Australia, China, and France), domestic violence has increased.[13]

Thus, a comprehensive understanding of the impact of COVID-19 on short-term and long-term alcohol use and related health harms is urgently needed to inform policy and practice. Our team of epidemiology and health policy experts will rapidly construct and disseminate guidelines for alcohol control policy recommendations based on a) a systematic scoping review of the literature, b) analyses of secondary data

sources, and c) systematically conducted expert interviews.

1.2 Aims of the knowledge synthesis

The aims of this project are to provide a rapid-response knowledge synthesis through the expeditious (within one month of project commencement) production of evidence-informed guidelines for alcohol control policy recommendations, and the further refinement of these guidelines based on the following analyses.

1. An assessment of the current state of knowledge regarding how similar crises (e.g., economic crises and natural disasters) affect alcohol consumption and health harms through a systematic scoping review, and an assessment of the transferability of these data to the current pandemic context.
2. An examination of changes in alcohol consumption in Canada since the start of the COVID-19 pandemic through a secondary analysis of population survey data and alcohol sales data.
3. A triangulation of knowledge from multiple disciplines and diverse experts to reach consensus on a) the expected short- and long-term impacts of the current pandemic on alcohol consumption and related health harms, and b) policy actions required to minimize the negative health effects from alcohol consumption during the current pandemic and future crises.

2.1 Review of how economic crises and natural disasters impact alcohol consumption and its harms

A systematic scoping review will be performed to assess how similar crises (economic crises and natural disasters) have affected both average volume of alcohol consumed and heavy episodic drinking, the prevalence of alcohol use disorders, and acute and chronic alcohol-related harms, with a focus on differences by gender and the effects of these crises on alcohol-related domestic violence. Furthermore, we will determine if these reviews examined how social isolation, anxiety, layoffs, and financial distress experienced as a result of these crises affected alcohol use and alcohol-related harms.

The review methodology will be based on the Project on a Framework for Rating Evidence in Public Health (PRECEPT),[14,15] will be performed in accordance with the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines,[16] and has been prospectively registered with PROSPERO.[17] MEDLINE, and EMBASE will be searched for journal articles. MedRxiv, OSFPREPRINTS, PsyArXiv, and SSRN will be searched for preprints. References contained in the articles included in the review will be examined for other relevant publications. Subject experts will be contacted for unpublished research. Quality assessment of each review will be performed using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) method.[18]

Search strategy and results

Medline and Embase:
Economic recession: 142
Pandemics: 59
Natural disaster: 142

Medline:

No.	Searches
1	Humans/
2	"surveys and questionnaires"/ or self report/ or health surveys/ or patient health questionnaire/
3	(survey$ or questionnaire$).tw,kf.
4	2 or 3
	Exposure
5	Economic recession/ or ((great or economic or financial) adj3 (depression$ or recession$ or crisis)).tw,kf. or recession.tw,kf.
	Outcome
6	exp alcohol drinking/ or exp alcohol-related disorders/ or alcohol abstinence/
7	(alcohol* adj3 (drink* or consum* or abuse or dependen* or disorder* or problem*)).tw,kf. or (alcoholi*).tw,kf. or (binge drink* or heavy drink*).tw,kf.
8	6 or 7
9	1 and 4 and 5 and 8
10	remove duplicates from 9

No.	Searches
1	Humans/
2	"surveys and questionnaires"/ or self report/ or health surveys/ or patient health questionnaire/
3	(survey$ or questionnaire$).tw,kf.

4	2 or 3
	Exposure
5	influenza, human/ or coronavirus infections/ or severe acute respiratory syndrome/ or SARS virus/ or idle east respiratory syndrome coronavirus/ or haemmorhagic fever, Ebola/ or cholera/ or exp dengue/ or dengue virus/
6	(flu or influenza* or coronavirus or covid* or sars* or ebola or mers or cholera or dengue).tw,kf.
7	5 or 6
8	pandemics/ or epidemics/ or (pandemic$ or epidemic$).tw,kf.
9	7 and 8
	Outcome
10	exp alcohol drinking/ or exp alcohol-related disorders/ or alcohol abstinence/
11	(alcohol* adj3 (drink* or consum* or abuse or dependen* or disorder* or problem*)).tw,kf. or (alcoholi*).tw,kf. or (binge drink* or heavy drink*).tw,kf.
12	10 or 11
13	1 and 4 and 9 and 12
14	remove duplicates from 13

No.	**Searches**
1	Humans/
2	"surveys and questionnaires"/ or self report/ or health surveys/ or patient health questionnaire/
3	(survey$ or questionnaire$).tw,kf.
4	2 or 3
	Exposure
5	exp radioactive hazard release/ or exp natural disasters/ or mass casualty incidents/ or Bhopal accidental release/ or Seveso accidental release/
6	((Chernobyl or Fukushima) adj3 (accident* or nuclear or disaster*)).tw,kf. or ((Bhopal or Seveso) adj3 (disaster or accident)).tw,kf. or (natural disaster).tw,kf. or (flood* or cyclonic storm* or drought* or earthquake* or landslide* or tidal wave* or tsunami* or tornado* or wildfire* or avalanche* or blizzard* or hurricane* or typhoon*).tw,kf.
7	5 or 6
	Outcome
8	exp alcohol drinking/ or exp alcohol-related disorders/ or alcohol abstinence/
9	(alcohol* adj3 (drink* or consum* or abuse or dependen* or disorder* or problem*)).tw,kf. or (alcoholi*).tw,kf. or (binge drink* or heavy drink*).tw,kf.
10	8 or 9
11	1 and 4 and 7 and 10
12	remove duplicates from 11

Embase:

No.	**Searches**
1	Human/
2	health survey/ or questionnaire/ or (survey$ or questionnaire$).tw,kw.
	Exposure
3	Economic recession/ or ((great or economic or financial) adj3 (depression$ or recession$ or crisis)).tw,kw. or recession.tw,kw.
	Outcome

4	exp alcohol drinking/ or exp alcoholic intoxication/ or exp alcohol consumption/ or exp alcohol abuse/ or exp alcoholism/
5	(alcohol* adj3 (drink* or consum* or abuse or dependen* or disorder* or problem*)).tw,kw. or (alcoholi*).tw,kw. or (binge drink* or heavy drink*).tw,kw.
6	4 or 5
7	1 and 2 and 3 and 6
8	remove duplicates from 7

No.	**Searches**
1	Human/
2	health survey/ or questionnaire/ or (survey$ or questionnaire$).tw,kw.
	Exposure
3	exp influenza/ or coronavirinae/ or coronaviridae/ or coronavirus infection/ or middle east respiratory syndrome/ or severe acute respiratory syndrome/ or ebola haemorrhagic fever/ or cholera/ or exp dengue
4	(flu or influenza* or coronavirus or covid* or sars* or ebola or mers or cholera or dengue).tw,kw.
5	3 or 4
6	pandemic/ or pandemic influenza/ or epidemic/ or (pandemic$ or epidemic$).tw,kw.
7	5 and 6
	Outcome
8	exp alcohol drinking/ or exp alcoholic intoxication/ or exp alcohol consumption/ or exp alcohol abuse/ or exp alcoholism/
9	(alcohol* adj3 (drink* or consum* or abuse or dependen* or disorder* or problem*)).tw,kw. or (alcoholi*).tw,kw. or (binge drink* or heavy drink*).tw,kw.
10	8 or 9
11	1 and 2 and 7 and 10
12	remove duplicates from 11

No.	**Searches**
1	Human/
2	health survey/ or questionnaire/ or (survey$ or questionnaire$).tw,kw.
	Exposure
3	exp nuclear accident/ or natural disaster/ or mass disaster/ or Bhopal disaster/ or Seveso accident/ or flooding/ or drought/ or blizzard/ or hurricane/ or tornado/ or earthquake/ or tsunami/ or wildfire/ or avalanche/
4	((Chernobyl or Fukushima) adj3 (accident* or nuclear or disaster*)).tw,kw. or ((Bhopal or Seveso) adj3 (disaster or accident)).tw,kw. or (natural disaster).tw,kw. or (flood* or cyclonic storm* or drought* or earthquake* or landslide* or tidal wave* or tsunami* or tornado* or wildfire* or avalanche* or blizzard* or hurricane* or typhoon*).tw,kw.
5	3 or 4
	Outcome
6	exp alcohol drinking/ or exp alcoholic intoxication/ or exp alcohol consumption/ or exp alcohol abuse/ or exp alcoholism/
7	(alcohol* adj3 (drink* or consum* or abuse or dependen* or disorder* or problem*)).tw,kw. or (alcoholi*).tw,kw. or (binge drink* or heavy drink*).tw,kw.
8	6 or 7
9	1 and 2 and 5 and 8
10	remove duplicates from 9

2.2 Knowledge Synthesis Project #2: Secondary analysis of data sources to assess changes in alcohol consumption

2.2.1 Paper 1: The impact of COVID-19 on alcohol consumption in Canada - Secondary analysis of survey data

The study outlined below is a manuscript submitted to:
Alcohol and Alcoholism

Running title: Alcohol and COVID-19

Changes in alcohol consumption in Canada during the COVID-19 pandemic: Associations with anxiety, depression and loneliness

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Abstract

Aim: To examine whether changes in alcohol consumption in Canada since the start of the COVID-19 pandemic are associated with feelings of anxiety, depression, loneliness, and changes in employment due to COVID-19.

Methods: Data collection occurred between May 29 and July 14, 2020 via a web panel, AskingCanadians, which sampled 2,943 adults (≥18 years of age). Data were collected on changes in alcohol consumption compared to before the pandemic (ordinal variable ranging from 1="much less alcohol" to 5="much more alcohol"), anxiety (General Anxiety Disorder-7), depression (Center for Epidemiologic Studies Depression Scale), loneliness, changes in employment status due to COVID-19, and socio-demographic variables (age, gender, living situation, household income, and urban vs rural residence). Multivariate associations were assessed using ordinal logistic regression. Effect modification by gender was tested using likelihood-ratio tests.

Results: Changes in alcohol consumption were positively associated with anxiety, feeling depressed, and loneliness. In particular, people with mild to moderate (ordered Odds Ratio (OR):1.33, 95% Confidence Interval (CI):1.09, 1.62) or severe anxiety (ordered OR:1.53, 95% CI:1.07, 2.20) had a greater odds of increased drinking than did people with no to low levels of anxiety. Changes in employment status, living situation, age, and household income were also associated with changes in drinking. No effect modifications by gender were observed.

Conclusion: Given the health harms associated with alcohol use, public health practitioners and primary care physicians should focus health messaging to identify and offer support to individuals most at risk of increased alcohol consumption, especially people experiencing depression, loneliness, or anxiety.

Keywords: alcohol, anxiety, depression, social isolation, COVID-19

Short Summary

This analysis of survey data found that increases in alcohol consumption among Canadian adults from the start of the COVID-19 pandemic were associated with higher anxiety, feelings of loneliness, and/or depression.

Introduction

The novel coronavirus disease (COVID-19) was declared a "public health emergency of international concern" on January 30, 2020 by the World Health Organization (WHO), and, as of July 13, 2020, there were approximately 12.8 million confirmed cases of COVID-19 in 216 countries, areas, or territories, with 566,000 confirmed fatalities (World Health Organization, 2020b). In Canada, as of July 12, 2020, there were more than 107,000 confirmed COVID-19 cases, and more than 8,700 confirmed deaths (Government of Canada, 2020). In the absence of pharmacological interventions, all provincial and territorial governments in Canada had declared COVID-19 a public health emergency by mid-April 2020, instituting measures including social-distancing policies to slow the spread of the disease (Office of the Premier, 2020, Lawrence, 2020, BC Gov News, 2020). While such restrictive measures may help to protect physical health, and work to prevent healthcare systems from becoming overwhelmed, such interventions may also have social and economic consequences.

Anxiety, depression, loneliness, and layoffs experienced as a result of a major disease outbreak may lead to increased alcohol consumption (Bolton et al., 2009, Leeies et al., 2010). Additionally, alcohol consumption may increase due to a blurring of work and leisure hours and the popularization of cocktail hour during a lockdown (Campbell, 2020). Alcohol consumption was a leading cause of mortality and morbidity in Canada even before the COVID-19 pandemic, particularly among adults 15 to 49 years of age (Rehm and Imtiaz, 2016, GBD 2016 Alcohol Collaborators, 2018, Rehm et al., 2010). Consequently, increased consumption as a result of the current pandemic will likely have immediate and long-term public health consequences, including increasing the transmission and worsening of the disease course of COVID-19 (World Health Organization, 2020a), and increasing the already high alcohol-attributable public health burden in Canada (Benzie, 2020, Zussman, 2020, Chaudhuri, 2020). Although a few ad-hoc reports from North America have shown increases in alcohol sales during the pandemic (Benzie, 2020, Zussman, 2020, Chaudhuri, 2020), scientific evidence of

such increases is sparse, and there is no coordinated policy effort to address a potential looming crisis resulting from this apparent increased consumption of alcohol (Rehm et al., 2020). Moreover, little evidence is available that identifies factors associated with increased drinking. Such information is needed to inform public health and policy efforts to dampen increases in alcohol use during the present and future health crises. Accordingly, the aim of this study was to identify factors associated with increases in alcohol consumption in Canada during the COVID-19 pandemic, with a focus on anxiety, depression, and loneliness, as well as changes in employment due to the pandemic. Given that stressors appear to have differential effects on the drinking behaviour of men and women (Peltier et al., 2019), this study also examined whether factors associated with changes in alcohol use were different for men and women.

Methods

Participants were recruited utilizing web-based panel surveys of adults 18 years of age and older living in Canada. Invitations to participate in the survey were sent to N=20,041 participants of an existing web panel (AskingCanadians) hosted by the Delvinia research firm. Participants were invited to participate in the surveys based on a quota sampling by age, gender, and region (proportional to the English-speaking Canadian population as the surveys were conducted in English).

Cross-sectional data used in our analysis were collected from May 29 to June 1, 2020 (wave 2), June 19 to 23, 2020 (wave 3) and July 10 to 14 (wave 4). Wave 1 (May 8 to 12, 2020) data were not included as changes in alcohol consumption were not measured for people who did not report drinking in the past week in this wave's survey. A total of 265 people were screened for the survey but were unable to participate, and 494 people responded to the survey request but were not sampled due to the respondent's quota being full. The response rate for Waves 2 to 4 combined was 15.6%; the response

rates by wave are outlined in Table S1 of the supplemental material. A total of N=2,943 people completed the surveys and answered all questions, data from which were used in our analyses.

Changes in each respondent's alcohol consumption since the start of the COVID-19 pandemic were measured on a 5-point monotonically increasing Likert scale, indicating whether in the past 7 days the respondent drank "much less alcohol", drank "slightly less alcohol", experienced "no change" in alcohol consumption, drank "slightly more alcohol", or drank "much more alcohol" compared to before the start of the pandemic.

Symptoms of anxiety were measured using the General Anxiety Disorder-7 (GAD-7) screening tool (Spitzer et al., 2006), which also measures symptom severity for anxiety disorders. All GAD-7 answers were measured using a 4-point Likert scale. Scores were summed across answers to estimate a summary measure of anxiety that has demonstrated high internal consistency (Cronbach's alpha: 0.94; 95% Confidence Interval (CI): 0.93, 0.94). The GAD-7 scores (0-21) were categorized as low (0-4), mild to moderate (5-14), and severe (≥15) anxiety. Symptoms of depression were measured by utilizing three questions from the Center for Epidemiologic Studies Depression Scale (CES-D) (Radloff, 1977). These questions used a past week time frame, questioning participants as to "how often have you felt depressed?", "how often have you felt lonely?", and/or "how often have you felt hopeful about the future?". These three items were measured using a 4-point Likert scale. The CES-D summary score has poor internal consistency (Cronbach's alpha: 0.58; 95% CI: 0.55, 0.60), and, accordingly, the answers to the CES-D questions were not combined into one summary measure.

For socio-demographic variables, respondents indicated their gender, age, household income, location of residence (urban, sub-urban or rural), and number of people living in their household. Respondents

were also asked if physical distancing measures due to the COVID-19 pandemic had affected their employment situation.

Statistical analyses

The evaluation of whether certain factors (i.e., demographic variables, depression symptoms, and/or anxiety symptoms) were associated with changes in alcohol consumption (compared to before the start of the COVID-19 pandemic) was determined using chi-square tests. To adjust for potential confounding across the examined factors, we measured associations using an ordinal logistic regression analysis, with changes in alcohol use operationalized as an ordinal categorical measure with the lowest category being the reporting of drinking much less alcohol in the past 7 days compared to before the COVID-19 pandemic, and the highest category being the reporting of drinking much more alcohol in the past 7 days compared to before the COVID-19 pandemic. Demographic variables, as well as measures of depression symptoms and/or anxiety symptoms, were included in all regression models. All ordinal logistic regression models were performed for the total sample and separately for men and women. To test for statistical interactions (i.e., effect modification) between gender and other independent variables, likelihood ratio tests were performed comparing the log likelihood statistics of models with interaction terms to those without interaction terms. The proportional log odds assumption was assessed by means of a visual inspection of the plotted log odds. A secondary analysis was performed to determine whether the wave of the survey was significantly associated with changes in alcohol consumption or affected the significance of other variables associated with changes in alcohol consumption. No population expansion weights were used as the sample was repetitive by design and it used quota sampling by age, gender, and region. All analyses were performed using the statistical software package R, version 4.0.1 (R Core Team, 2013).

Data are available upon request.

Results

A total of 1461 women, 1465 men, and 26 people who did not identify as either a man or a woman, participated in the study. Primarily, participants were 30-39 years of age (25.5%), had a household income of $40,000-$79,000 per year (23.7%), lived in an urban area (46.7%), lived with others (79.2%), and had experienced no change in employment status due to the COVID-19 pandemic (including having been a student or retired before the economic crisis) (37.5%) (see Table 1).
A total of 61.4% of all participants were current drinkers (based on the past 7 days). Compared to before the COVID-19 pandemic, 5.8% of all survey participants reported drinking much less alcohol, 5.9% reported drinking slightly less alcohol, 17.8% reported drinking slightly more alcohol, 4.8% reported drinking much more alcohol, and 65.8% indicated no change in their consumption.

GAD-7 summary scores indicated that 53.0%, 38.6%, and 8.5% of the participants had no to low, mild to moderate, or severe anxiety, respectively (see Table 2). A total of 19.5% and 22.7% of the participants reported that they felt depressed or lonely, respectively, at least 3 or more days in the past week. Furthermore, a total of 52.4% said they felt hopeful for the future on 0 to 2 days per week.

< Insert Tables 1 and 2 about here >

Bivariate tests indicated that anxiety and the number of days the participant felt depressed, lonely, and/or hopeful about the future were significantly associated with changes in alcohol consumption (see Tables S2 to S7 in the supplemental material). Age, household income, changes in employment status, and residence were also associated with changes in consumption. The multivariable ordinal regression models indicated that anxiety and the number of days a respondent felt depressed or lonely were significantly associated with self-reported changes in alcohol consumption, controlling for the socio-

demographic variables (see Tables 3 and 4). The ordered Odds Ratios (ORs) are reported below – these should be interpreted as the odds of being in the higher category of change in alcohol use (compared to a lower category one below) – these categories ranged from drinking much less to drinking much more alcohol in the past 7 days compared to before the COVID-19 pandemic. The analysis found that people 40 to 49 years of age (ordered OR 1.47; 95% CI: 1.10, 1.96) were more likely to report a higher category of change in alcohol use (and therefore more likely to have an increase in alcohol consumption) than were people 18 to 29 years of age. Individuals who lived with others were more likely to report a higher category of change in alcohol use (ordered OR: 1.27; 95% CI: 1.04, 1.56) than were people who lived alone. People who had an annual income of $120,000 and over per year (ordered OR: 1.48; 95% CI: 1.11, 1.97) were more likely to report a higher category of change in alcohol use than were people with incomes of less than $40,000 per year. Further, people who worked from home as a result of the pandemic (ordered OR: 1.34; 95% CI: 1.00, 1.79) were more likely to report a higher category of change in alcohol use than were people who experienced no change in their employment status.

< Insert Table 3 about here >

People with mild to moderate anxiety (ordered OR: 1.33; 95% CI: 1.09, 1.62) or severe anxiety (ordered OR: 1.53; 95% CI: 1.07, 2.20) were more likely to report a higher category of change in alcohol use than were people who had low levels of anxiety. People who reported feeling depressed 1 to 2 days (ordered OR: 1.26; 95% CI: 1.02, 1.56) or 3 to 4 days in the previous week (ordered OR: 1.41; 95% CI: 1.04, 1.90) were also more likely to report a higher category of change in alcohol use than were people who did not feel depressed in the past week. People who reported feeling lonely 3 to 4 days in the previous week (ordered OR: 1.48; 95% CI: 1.13, 1.93) or 5 to 7 days in the previous week (ordered OR: 1.61; 95% CI: 1.12, 2.31) were more likely to have a higher category of change in alcohol

use than were people who did not feel lonely in the past week. No significant differences in the ordered ORs were observed by gender, residence location, or the number of days in the past week a person felt hopeful about the future.

< Insert Table 4 about here >

In the secondary data analyses, the wave of the survey was not significantly associated with changes in alcohol consumption and did not affect the significance of other associations when included in the statistical model (see Tables S8 and S9 in the supplemental material).

In models performed separately for both men and women (see Tables 3 and 4), the number of days a respondent felt lonely was significantly associated with changes in alcohol consumption for both men and women. Age, living situation, and the number of days feeling depressed were significantly associated with changes in alcohol consumption for men but not for women. Furthermore, income, changes in employment status, and anxiety were significantly associated with changes in alcohol consumption for women but not for men. Finally, the number of days a respondent felt lonely was significantly associated with changes in alcohol consumption for both women and men.

Despite differences in the significance of ordered ORs for independent variables when modelling data stratified by gender, the assessment through likelihood ratio tests for interactions of gender with age, household income, a person's living situation, anxiety, and the number of days feeling depressed in the past week in association with changes in alcohol consumption showed that such interactions were not statistically significant (see Table S10 in the supplemental material).

Discussion

The present study indicated that changes in alcohol consumption were significantly associated with anxiety, feeling depressed, and loneliness, with people who with higher levels of anxiety, and more frequent feelings of depression and loneliness, being most likely to increase their alcohol consumption. Furthermore, changes in alcohol consumption were significantly associated with age, household income, a person's living situation, and changes in employment status. Changes in alcohol consumption were not significantly associated with gender, location of residence (urban, suburban or rural) or the number of days in the past week a person felt hopeful about the future.

The COVID-19 pandemic and social distancing measures have been associated with increases in anxiety and depression (Wang et al., 2020, Shevlin et al., 2020). The exact reasons for increases in alcohol consumption during the COVID-19 pandemic are unknown; however, the present cross-sectional study suggests that increases in anxiety, feelings of depression, and/or loneliness may lead to increases in alcohol consumption. However, this relationship may be bi-directional, with increased alcohol consumption also increasing anxiety and/or feelings of depression (Rehm et al., 2017).

Household income was significantly associated with changes in alcohol consumption. This may be explained, in part, by the fact that people in higher socio-economic status groups are less sensitive to environmental changes (e.g., price changes and financial strains (Holmes et al., 2014)) compared to people in lower socio-economic status groups. It is unknown if people in higher socio-economic status groups are more likely to increase their alcohol consumption in response to the COVID-19 pandemic compared to people in lower socio-economic groups. The observed association of changes in employment status with changes in alcohol consumption may be due, in part, to a blurring of work and leisure hours and the popularization of cocktail hour during a lockdown (Campbell, 2020).

The observed changes in alcohol consumption differed for people of different ages. In particular, alcohol consumption increased among people 40 to 49 years of age compared to people 18 to 29 years of age. This may be due to the differing contexts of alcohol consumption by age, and to the closing of on-premise drinking establishments during the pandemic. Indeed, people of younger ages are more likely to consume alcohol on premise, whereas people who are older in age are more likely to consume alcohol off premise (Treno et al., 2000). Thus, the latter group may have been more likely to increase their drinking due to their general propensity to drink at home.

Although the statistical tests were not significant for the interactions of gender with a person's living situation, household income, anxiety, and feeling depressed or lonely in association with changes in alcohol consumption, these interactions may become significant when a larger sample size is studied.

The findings of this study should be viewed within the context of its limitations, particularly with respect to its representativity. Firstly, the surveys were performed in English only, and therefore the quota sampling was designed to be representative of English-speaking or bilingual Canadians. As a result, the effects of the COVID-19 pandemic on alcohol consumption during the studied time period may be underestimated as Quebec has experienced the highest COVID-19 incidence and mortality rates in Canada (Government of Canada, 2020). Secondly, the AskingCanadians web panel had a response rate of 15.3% (see Table S1 in the supplemental material). Although quota sampling was used to achieve an age-, sex-, and regionally-representative sample, participation bias may have been introduced since people who are more likely to participate in surveys typically consume less alcohol (Shield and Rehm, 2012); however, it is currently unclear whether participation bias affects the measurement of changes in alcohol consumption. Furthermore, the low response rate should not notably bias the measurement of the relationship between changes in alcohol consumption and demographics, anxiety, and depression as response rates do not affect the measurement of associations

(Groves, 2004) (with the exception of effect modification where the association of interest differs in magnitude or direction across subgroups which are less likely to participate or be surveyed).

The measurement of changes in alcohol consumption is limited by several factors. Firstly, this measurement is retrospective and cross-sectional, and therefore it is susceptible to recall bias (Groves, 2004). Secondly, the measurement of changes in alcohol consumption is based on self-reporting, and thus is subjective. Therefore, small changes in alcohol consumption may be indicated as no change; however, small changes in alcohol consumption at the individual level may have a large impact on public health (Groves, 2004). Furthermore, reporting of changes in alcohol consumption may be susceptible to response bias where the respondent deliberately misreports changes in consumption to conform to social norms (Randall and Fernandes, 1991); this form of bias has been observed previously for highly stigmatized behaviours, such as alcohol use and mental health problems (Johnson et al., 1999, Randall and Fernandes, 1991, Shield and Rehm, 2012). Lastly, the measurement of changes in alcohol consumption is with respect to overall consumption, and therefore the findings of this study may not apply to changes in drinking status, the frequency of alcohol consumption, the volume of alcohol consumed during drinking occasions, and engaging in heavy episodic drinking.

Conclusions

This study's findings suggest that changes in alcohol consumption since the start of the COVID-19 pandemic are associated with anxiety, feeling depressed, and/or loneliness. In particular, increases in anxiety and depression due to the pandemic may have contributed to increases in alcohol consumption; however, the potential for reverse causality was not accounted for in this study.

Although it is currently unknown if changes in alcohol consumption during the pandemic will persist after the pandemic, increased alcohol consumption during the pandemic will have immediate negative

health effects on the burden of infectious diseases, non-communicable diseases, and injuries in Canada. It will be important to continue monitoring alcohol consumption as physical distancing restrictions are eased as well as the long-term effects of the pandemic on drinking patterns and associated health outcomes. However, in the short-term, public health policies and primary care physicians should offer support to people whose alcohol consumption has increased, and in particular to those people with increased anxiety and depression.

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Tables

Table 1. Demographic characteristics of the web panel sample, by gender

Table 2. Alcohol consumption, anxiety, and depression measures of the web panel sample, by gender

Table 3. Adjusted Ordered Odds Ratios for changes in alcohol consumption by demographic measures

Table 4. Adjusted Ordered Odds Ratios for changes in alcohol consumption, stratified by measures of anxiety, depression, loneliness, and hopefulness

Table 1. Demographic characteristics of the web panel sample, by gender

		Total		Men		Women	
		Prevalence (%)	(95% CI)	Prevalence (%)	(95% CI)	Prevalence (%)	(95% CI)
Gender	Male	49.6	(47.8, 51.4)				
	Female	49.5	(47.7, 51.3)				
	Other	0.9	(0.6, 1.3)				
Age (years)	18 to 29	13.1	(11.9, 14.4)	11.0	(9.4, 12.7)	15.1	(13.3, 17.0)
	30 to 39	25.5	(24.0, 27.2)	27.5	(25.2, 29.9)	23.5	(21.4, 25.8)
	40 to 49	14.3	(13.0, 15.6)	13.9	(12.2, 15.8)	14.5	(12.7, 16.4)
	50 to 59	16.8	(15.5, 18.2)	17.1	(15.2, 19.1)	16.5	(14.6, 18.5)
	60 to 69	18.1	(16.7, 19.5)	17.6	(15.7, 19.7)	18.8	(16.8, 20.9)
	70 and older	12.2	(11.0, 13.4)	12.9	(11.2, 14.7)	11.6	(10.0, 13.4)
Living situation	Live alone	20.8	(19.3, 22.3)	20.3	(18.3, 22.5)	20.9	(18.9, 23.1)
	Live with someone else	79.2	(77.7, 80.7)	79.7	(77.5, 81.7)	79.1	(76.9, 81.1)
Household income (per year)	<$40,000	12.2	(11.1, 13.5)	11.5	(9.9, 13.3)	12.7	(11.1, 14.5)
	40,000 to 79,000	23.7	(22.2, 25.3)	23.1	(21.0, 25.4)	24.4	(22.2, 26.7)
	$80,000 to $119,000	22.2	(20.7, 23.7)	24.4	(22.2, 26.7)	20.1	(18.1, 22.3)
	$120,000 and over	25.6	(24.0, 27.2)	28.4	(26.1, 30.8)	23.1	(20.9, 25.3)
	Prefer not to answer	16.3	(14.9, 17.6)	12.6	(10.9, 14.4)	19.7	(17.7, 21.8)
Changes in employment status	No change	9.4	(8.4, 10.5)	10.1	(8.6, 11.8)	8.8	(7.4, 10.3)
	Unemployed	11.2	(10.1, 12.4)	11.9	(10.3, 13.6)	10.4	(8.9, 12.1)
	Newly employed	4.1	(3.4, 4.8)	3.7	(2.8, 4.8)	4.4	(3.5, 5.6)
	Student / retired	28.1	(26.5, 29.8)	24.7	(22.5, 27.0)	31.5	(29.1, 33.9)
	Working from home	25.3	(23.7, 26.9)	25.8	(23.6, 28.1)	24.8	(22.6, 27.1)
	Other	21.9	(20.4, 23.5)	23.8	(21.7, 26.1)	20.1	(18.0, 22.2)
Residence	Urban	46.7	(44.9, 48.5)	48.7	(46.1, 51.3)	44.6	(42.1, 47.2)
	Suburban	37.1	(35.3, 38.8)	37.6	(35.1, 40.1)	36.8	(34.3, 39.4)
	Rural	16.2	(14.9, 17.6)	13.7	(11.9, 15.5)	18.5	(16.6, 20.6)

Table 2. Alcohol consumption, anxiety, and depression measures of the web panel sample, by gender

		Total		Men		Women	
		Prevalence (%)	(95% CI)	Prevalence (%)	(95% CI)	Prevalence (%)	(95% CI)
Drinking status	Drinker	61.4	(59.7, 63.2)	65.6	(63.1, 68.0)	57.4	(54.8, 60.0)
	Abstainer	38.6	(36.8, 40.3)	34.4	(32.0, 36.9)	42.6	(40.0, 45.2)
Changes in drinking	Drank much less alcohol	5.8	(5.0, 6.7)	5.4	(4.3, 6.7)	6.3	(5.1, 7.7)
	Drank slightly less alcohol	5.9	(5.0, 6.8)	7.0	(5.7, 8.4)	4.7	(3.7, 5.9)
	No change	65.8	(64.0, 67.5)	64.2	(61.6, 66.6)	67.6	(65.2, 70.0)
	Drank slightly more alcohol	17.8	(16.4, 19.2)	18.2	(16.3, 20.3)	17.2	(15.3, 19.2)
	Drank much more alcohol	4.8	(4.0, 5.6)	5.3	(4.2, 6.5)	4.2	(3.2, 5.3)
Anxiety (GAD-7 score)	Low (0 to 4)	53.0	(51.2, 54.8)	58.1	(55.5, 60.6)	48.0	(45.5, 50.6)
	Mild to moderate (5 to 14)	38.6	(36.8, 40.3)	35.3	(32.8, 37.8)	41.9	(39.3, 44.5)
	Severe (15 or greater)	8.5	(7.5, 9.5)	6.6	(5.4, 8.0)	10.1	(8.6, 11.7)
Number of days feeling depressed	None	55.3	(53.5, 57.1)	60.8	(58.2, 63.3)	50.2	(47.6, 52.8)
	1 to 2	25.2	(23.6, 26.8)	22.7	(20.5, 24.9)	27.7	(25.4, 30.0)
	3 to 4	13.3	(12.1, 14.6)	11.6	(10.0, 13.4)	14.9	(13.1, 16.9)
	5 to 7	6.2	(5.4, 7.1)	5.0	(3.9, 6.2)	7.2	(5.9, 8.6)
Number of days feeling lonely	None	52.8	(51.0, 54.6)	57.6	(55.0, 60.2)	48.3	(45.7, 50.9)
	1 to 2	24.5	(23.0, 26.1)	22.0	(19.9, 24.2)	27.3	(25.0, 29.7)
	3 to 4	14.3	(13.1, 15.6)	13.9	(12.2, 15.8)	14.6	(12.8, 16.5)
	5 to 7	8.4	(7.4, 9.4)	6.5	(5.3, 7.9)	9.9	(8.4, 11.5)
Number of days feeling hopeful about the future	None	21.0	(19.6, 22.6)	21.5	(19.4, 23.7)	20.5	(18.4, 22.6)
	1 to 2	31.4	(29.7, 33.1)	28.7	(26.4, 31.1)	34.0	(31.6, 36.5)
	3 to 4	29.3	(27.7, 31.0)	31.4	(29.0, 33.8)	27.2	(24.9, 29.5)
	5 to 7	18.3	(16.9, 19.7)	18.4	(16.4, 20.4)	18.3	(16.4, 20.4)

Table 3. Adjusted Ordered Odds Ratios for changes in alcohol consumption by demographic measures

Independent variable		Total			Men			Women		
		Ordered OR*	(95% CI)	p value	Ordered OR*	(95% CI)	p value	Ordered OR*	(95% CI)	p value
Gender	Male	1.12	(0.96, 1.30)	0.15						
	Female	REF	-	-						
	Other	1.61	(0.73, 3.56)	0.24						
Age (years)	18 to 29	REF	-	-	REF	-	-	REF	-	-
	30 to 39	1.16	(0.89, 1.50)	0.27	1.21	(0.82, 1.78)	0.34	1.11	(0.77, 1.59)	0.58
	40 to 49	1.47	(1.10, 1.96)	<0.01	1.84	(1.20, 2.84)	<0.01	1.13	(0.75, 1.70)	0.55
	50 to 59	1.05	(0.80, 1.39)	0.71	1.11	(0.73, 1.69)	0.62	0.95	(0.65, 1.40)	0.80
	60 to 69	1.07	(0.80, 1.43)	0.66	0.98	(0.62, 1.53)	0.91	1.14	(0.76, 1.70)	0.52
	70 and older	1.22	(0.87, 1.71)	0.24	1.20	(0.73, 1.96)	0.48	1.14	(0.70, 1.83)	0.60
Living situation	Live alone	REF	-	-	REF	-	-	REF	-	-
	Live with someone else	1.27	(1.04, 1.56)	0.02	1.38	(1.03, 1.83)	0.03	1.15	(0.86, 1.55)	0.34
Household income (per year)	<$40,000	REF	-	-	REF	-	-	REF	-	-
	40,000 to 79,000	1.06	(0.81, 1.38)	0.68	0.98	(0.66, 1.44)	0.90	1.15	(0.79, 1.69)	0.47
	$80,000 to $119,000	1.29	(0.97, 1.71)	0.08	1.15	(0.77, 1.72)	0.50	1.49	(1.00, 2.24)	0.05
	$120,000 and over	1.48	(1.11, 1.97)	<0.01	1.40	(0.92, 2.12)	0.11	1.55	(1.03, 2.34)	0.04
	Prefer not to answer	0.99	(0.74, 1.33)	0.96	1.12	(0.72, 1.76)	0.61	0.95	(0.63, 1.43)	0.81
Changes in employment status	No change	REF	-	-	REF	-	-	REF	-	-
	Newly employed	1.25	(0.80, 1.96)	0.33	0.88	(0.45, 1.69)	0.70	1.63	(0.86, 3.10)	0.13
	Unemployed	1.25	(0.80, 1.96)	0.33	1.23	(0.78, 1.95)	0.38	1.15	(0.69, 1.92)	0.58
	Student / retired	1.03	(0.76, 1.40)	0.85	0.91	(0.59, 1.41)	0.68	1.22	(0.78, 1.90)	0.38
	Working from home	1.34	(1.00, 1.79)	0.047	1.19	(0.80, 1.77)	0.39	1.56	(1.02, 2.41)	0.04
	Other	1.12	(0.83, 1.50)	0.46	1.04	(0.70, 1.55)	0.83	1.21	(0.78, 1.89)	0.40
Residence	Rural	REF	-	-	REF	-	-	REF	-	-
	Suburban	0.95	(0.76, 1.18)	0.64	0.93	(0.67, 1.30)	0.68	0.99	(0.73, 1.34)	0.94
	Urban	0.87	(0.70, 1.09)	0.23	0.97	(0.70, 1.34)	0.86	0.81	(0.60, 1.10)	0.18

OR: Odds Ratio

* Ordinal categorization of changes in alcohol consumption (lowest to highest): drank “much less alcohol”, drank “slightly less alcohol", experienced "no change" in alcohol consumption, drank “slightly more alcohol”, or drank “much more alcohol” compared to before the start of the COVID-19 pandemic

* All models included measures of anxiety and depression (see Table 4)

Table 4. Adjusted Ordered Odds Ratios for changes in alcohol consumption, stratified by measures of anxiety, depression, loneliness, and hopefulness

Independent variable		Total			Men			Women		
		Ordered OR*	(95% CI)	p value	Ordered OR*	(95% CI)	p value	Ordered OR*	(95% CI)	p value
Anxiety (GAD-7 score)	Low (0 to 4)	REF	-	-	REF	-	-	REF	-	-
	Mild to moderate (5 to 14)	1.33	(1.09, 1.62)	<0.01	1.12	(0.96, 1.30)	0.15	1.37	(1.04, 1.81)	0.03
	Severe (15 or greater)	1.53	(1.07, 2.20)	0.02	1.60	(0.72, 3.54)	0.25	1.26	(0.78, 2.06)	0.35
Number of days feeling depressed	None	REF	-	-	REF	-	-	REF	-	-
	1 to 2	1.26	(1.02, 1.56)	0.03	1.05	(0.80, 1.39)	0.72	1.11	(0.83, 1.49)	0.46
	3 to 4	1.41	(1.04, 1.90)	0.03	1.47	(1.10, 1.96)	<0.01	1.32	(0.88, 1.97)	0.18
	5 to 7	1.41	(0.91, 2.18)	0.12	1.16	(0.89, 1.50)	0.26	1.23	(0.68, 2.22)	0.50
Number of days feeling lonely	None	REF	-	-	REF	-	-	REF	-	-
	1 to 2	1.06	(0.87, 1.30)	0.55	1.48	(1.11, 1.97)	<0.01	1.04	(0.79, 1.38)	0.77
	3 to 4	1.48	(1.13, 1.93)	<0.01	1.22	(0.87, 1.71)	0.24	1.61	(1.11, 2.33)	0.01
	5 to 7	1.61	(1.12, 2.31)	<0.01	1.07	(0.80, 1.43)	0.66	1.62	(0.99, 2.64)	0.05
Number of days feeling hopeful about the future	None	0.85	(0.66, 1.09)	0.20	1.29	(0.97, 1.70)	0.08	0.92	(0.64, 1.33)	0.66
	1 to 2	0.97	(0.77, 1.23)	0.83	1.00	(0.74, 1.34)	0.97	1.18	(0.85, 1.65)	0.32
	3 to 4	0.89	(0.71, 1.12)	0.31	1.06	(0.81, 1.38)	0.68	0.92	(0.65, 1.28)	0.61
	5 to 7	REF	-	-	REF	-	-	REF	-	-

OR: Odds Ratio

* Ordinal categorization of changes in alcohol consumption (lowest to highest): drank “much less alcohol”, drank “slightly less alcohol", experienced "no change" in alcohol consumption, drank “slightly more alcohol”, or drank “much more alcohol” compared to before the start of the COVID-19 pandemic

* All models included demographics measures (see Table 3)

2.2.2 Validation of the survey data analysis using per capita consumption data

To validate the from the individual-level data analysis, we will examine trends in alcohol sales data from all accessible provincial data sources – specifically, weekly sales data from the Liquor Control Board of Ontario Sale of Data program and the British Columbia direct sales databases. An autoregressive integrated moving average (ARIMA) model will be used to assess the impact of COVID-19 policies on alcohol sales. ARIMA models will be constructed according to the methods of Sadish *et al.*[42]

Weekly data have now been obtained from the LCBO from 2010 onward (until August 15, 2020). These data will be analyzed to assess time impact of COVID-19 and associated social distancing policies on alcohol consumption.

2.2.3 Comparison of survey data analysis with data from a European study

We will compare our findings to the findings of an ongoing European study being conducted in over 20 countries, which focusses on changes in distress and availability of alcohol on alcohol use during the COVID-19 pandemic (bildungsportal.sachsen.de/umfragen/limesurvey/index.php/684654?lang=en).

2.3 Knowledge Synthesis Project #3: Expert interviews to discuss triangulating the evidence and policy recommendations

Nominal group interviews are effective for triangulating knowledge from multiple disciplines and reaching a consensus among diverse experts where disagreements may exist.[43-45] Accordingly, two rounds of nominal group interviews will be conducted utilizing at least 20 internationally recognized alcohol health and policy experts (based on recommendations of McMillan and colleagues [45]) to systematically consolidate evidence and reach a consensus on a) the expected short- and long-term impacts of the current pandemic on alcohol consumption and related health harms, and b) policy actions required to minimize the negative health effects from alcohol consumption during the current pandemic and future crises. To identify individuals with relevant expertise, MEDLINE, EMBASE, and Web of Science will be searched for relevant publications using the search terms: “alcohol” AND “policy”. Additional, experts will be identified using the “expertscape” database using the same search terms. Seven experts have agreed to participate in the study so far (see letters of support).

In the first round, each expert will be provided with the results of the systematic scoping review and the analyses of alcohol consumption data. Experts will be asked to provide free text comments on the interpretation of these studies. Where necessary, experts will be contacted to clarify their answers. The project team will analyze the answers to identify potential underlying patterns and prepare a draft consensus position. In the second round of interviews, based on feedback about the results of round 1, the consolidated information will be provided to participants. During these interviews, experts will

interact and clarify their positions in small group virtual meetings. At the end of the second round of interviews, all experts will be asked to complete a questionnaire which will be used to build a consensus.

3.1 Knowledge Synthesis and Mobilization Activities

Throughout the project updated results and concrete actionable policy recommendations will be shared with CIHR and with diverse key Canadian stakeholders from multiple sectors (e.g., Canadian Centre on Substance Use and Addiction, Addictions and Mental Health Ontario, the Canadian Mental Health Association, and public health agencies). Results will also be shared via webinars, info graphics and peer reviewed scientific journal articles. Results will also be disseminated using EENet, an Ontario-wide addictions knowledge exchange network that works to close the gap between the creation and uptake of evidence. We will search for and engage with similar networks in other provinces. The WHO will assist in the knowledge dissemination efforts to international public health decision makers.

Table 3.1.1. Knowledge dissemination plans

Product/Tactic/Strategy	Target audience(s)	Partner organization(s) engaged in knowledge dissemination	Timing	Will the product be bilingual (Y/N)
Open access publications in national and international peer-reviewed journals	Researchers, healthcare providers, and healthcare administrators	Centre for Addiction and Mental Health, Canadian Centre on Substance Use and Addiction	Months 2 to 6	N (the abstracts will be published in English and French if the journals allow this option).
News releases	News media, researchers,	Centre for Addiction and Mental Health,	Months 2 to 6	Y

	healthcare providers, and healthcare administrators	Canadian Centre on Substance Use and Addiction, Canadian Institute for Substance Use Research, and peer-reviewed journals		
Webinars	Researchers, health care providers, and healthcare administrators	Centre for Addiction and Mental Health, Canadian Centre on Substance Use and Addiction, Canadian Institute for Substance Use Research, World Health Organization (WHO), Pan American Health Organization (PAHO), European Office of the WHO	Months 5 and 6	N
Infographics	The general public, decision makers, policy makers, healthcare administrators, healthcare providers, researchers, and other key stakeholder groups	Canadian Centre on Substance Use and Addiction, Centre for Addiction and Mental Health, Canadian Institute for Substance Use Research	Months 5 and 6	Y
Fact sheets	The general public decision makers, policy makers, healthcare administrators, healthcare providers, researchers, and other key	Centre for Addiction and Mental Health, Canadian Centre on Substance Use and Addiction, Canadian Institute for Substance Use Research, WHO, PAHO, European Office of the WHO	Months 5 and 6	Y

	stakeholder groups			
Dissemination of results through EENet	Decision makers, policy makers, healthcare administrators, healthcare providers, researchers, and other key stakeholder groups	Centre for Addiction and Mental Health	Months 5 and 6	N
Report	Decision makers, policy makers, healthcare administrators, healthcare providers, researchers, and other key stakeholder groups	Centre for Addiction and Mental Health, Canadian Centre on Substance Use and Addiction, Canadian Institute for Substance Use Research	Month 6	N

4.1 Findings of the knowledge synthesis

During the COVID-19 pandemic, more people have increased their alcohol consumption in Canada than have decreased their alcohol consumption. As identified in previous systematic reviews, those cost-effective interventions which are aimed at reducing alcohol-related harms include increases in price or taxation, decreases in availability, and restrictions on marketing. Additional interventions include brief interventions for people with alcohol use disorders. The effects of the current pandemic and associated social distancing policies on unrecorded alcohol consumption (i.e., alcohol which is not tracked by any level of government) are unknown; however, where increases in methanol poisonings have been observed, managed alcohol programs at homeless shelters may be an effective method of harms reduction. Further analyses and syntheses of the identified academic and grey literature will be conducted, and this lay summary section will be updated accordingly on a monthly basis.

4.2 implications of this knowledge synthesis

More people in Canada have increased their alcohol consumption during the COVID-19 pandemic than have reduced their alcohol consumption. Increases in alcohol consumption have been particularly high among people 40 to 49 years of age, those who reported having an increased level of anxiety, and those who reported feeling lonely. Increases in alcohol consumption are expected to result in an increase in short-term and long-term harms from communicable diseases, non-communicable diseases, and injuries. Further analyses will be conducted to assess the validity of the survey findings that alcohol consumption has increased during the pandemic period. It is currently not known if relaxation of social distancing policies in Canada will lead to increases or decreases in alcohol consumption. Analyses in months 2 to 6 will address this knowledge gap. If alcohol consumption remains elevated, alcohol policies may be needed to offset any potential increases in alcohol-related harms.

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Supplemental Material

Changes in alcohol consumption in Canada during the COVID-19 pandemic: Associations with anxiety, depression and loneliness

Table of Contents

Table S1. Response rates for waves 2 and 3 of the AskingCanadians web panel hosted by the Delvinia research firm 44

Table S2. Changes in drinking status by demographic measures 45

Table S3. Changes in drinking status by measures of anxiety, depression, loneliness, and hopefulness 46

Table S4. Changes in drinking status by demographic measures among men..... 47

Table S5. Changes in drinking status by measures of anxiety, depression, loneliness, and hopefulness 48

Table S6. Changes in drinking status by demographic measures among women..... 49

Table S7. Changes in drinking status by measures of anxiety, depression, loneliness, and hopefulness 50

Table S8. Adjusted Ordered Odds Ratios for changes in alcohol consumption by demographic measures (while controlling for survey wave)..... 51

Table S9. Adjusted Ordered Odds Ratios for changes in alcohol consumption by measures of anxiety, depression, loneliness and hopefulness (while controlling for survey wave)..... 52

Table S10. Log likelihood ratio tests for effect modification by gender 53

Table S1. Response rates for waves 2 and 3 of the AskingCanadians web panel hosted by the Delvinia research firm

Indicator	Wave 2	Wave 3	Wave 4	Waves 2, 3 and 4
Invitations sent	6,130	6,336	7,575	20,041
Survey status				
Complete	1,002	1,005	1,003	3,010
Incomplete	129	114	112	355
Screened	89	76	100	265
Responded but quota was full	213	131	150	494
Data available for all questions of interest	987	982	974	2,943
Response rate (for the survey)	17.2%	16.4%	13.7%	15.6%
Response rate (after removing participants with missing data)	16.9%	16.0%	13.3%	15.3%

Table S2. Changes in drinking status by demographic measures

Independent variable		Total (N)	Prevalence (across sub-categories)					p value
			Drink much less alcohol (N=172)	Drink slightly less alcohol (N=173)	No change (N=1942)	Drink slightly more alcohol (N=524)	Drink much more alcohol (N=141)	
Gender	Male	1465	5.4	7.0	64.2	18.2	5.3	0.07
	Female	1461	6.3	4.7	67.6	17.2	4.2	
	Other	26	3.8	7.7	53.8	23.1	11.5	
Age (years)	18 to 29	220	5.0	4.1	70.0	17.3	3.6	0.04
	30 to 39	344	4.7	7.0	64.5	17.2	6.7	
	40 to 49	212	9.4	3.3	61.3	20.3	5.7	
	50 to 59	241	5.0	4.6	71.8	15.4	3.3	
	60 to 69	274	8.4	4.4	65.7	19.0	2.6	
	70 and older	170	5.9	3.5	75.9	12.9	1.8	
Living situation	Live alone	306	7.8	3.9	69.9	14.1	4.2	0.34
	Live with someone else	1155	5.9	4.9	67.0	18.0	4.2	
Household income (year)	<$40,000	186	9.1	1.6	73.1	11.3	4.8	<0.01
	40,000 to 79,000	356	6.5	4.2	68.3	18.3	2.8	
	$80,000 to $119,000	294	5.1	4.8	65.3	21.1	3.7	
	$120,000 and over	337	3.6	6.2	64.7	20.2	5.3	
	Prefer not to answer	288	8.7	5.6	69.1	12.2	4.5	
Change in employment status	No change	128	7.0	3.9	74.2	13.3	1.6	<0.01
	Unemployed	152	5.3	6.6	68.4	12.5	7.2	
	Newly employed	65	6.2	3.1	64.6	16.9	9.2	
	Student / retired	460	7.2	3.3	70.7	16.7	2.2	
	Working from home	363	5.0	7.2	59.8	22.3	5.8	
	Other	293	6.8	3.8	70.0	15.7	3.8	
Residence	Urban	652	9.0	5.2	64.1	17.6	4.0	0.01
	Suburban	538	4.5	3.7	70.3	16.9	4.6	
	Rural	271	3.3	5.5	70.8	16.6	3.7	

Table S3. Changes in drinking status by measures of anxiety, depression, loneliness, and hopefulness

Independent variable		Total (N)	Prevalence (across sub-categories)					p value
			Drink much less alcohol (N=172)	Drink slightly less alcohol (N=173)	No change (N=1942)	Drink slightly more alcohol (N=524)	Drink much more alcohol (N=141)	
Anxiety (GAD-7 score)	Low (0 to 4)	702	6.4	3.8	76.2	12.3	1.3	<0.01
	Mild to moderate (5 to 14)	612	6.5	5.9	58.8	22.5	6.2	
	Severe (15 or greater)	147	4.8	4.1	63.3	18.4	9.5	
Number of days feeling depressed	None	734	6.0	4.5	74.3	13.5	1.8	<0.01
	1 to 2	404	6.7	5.4	63.4	19.1	5.4	
	3 to 4	218	6.0	5.5	56.4	25.2	6.9	
	5 to 7	105	7.6	1.9	61.0	19.0	10.5	
Number of days feeling lonely	None	705	5.5	6.1	71.9	14.6	1.8	<0.01
	1 to 2	399	7.5	3.8	67.9	16.3	4.5	
	3 to 4	213	6.1	2.8	59.2	24.9	7.0	
	5 to 7	144	6.9	3.5	58.3	20.8	10.4	
Number of days feeling hopeful about the future	None	299	10.0	3.0	64.9	16.7	5.4	<0.01
	1 to 2	497	4.6	6.0	62.0	21.9	5.4	
	3 to 4	397	5.5	5.0	72.3	14.1	3.0	
	5 to 7	268	6.3	3.7	74.3	13.4	2.2	

Table S4. Changes in drinking status by demographic measures among men

Independent variable		Total (N)	Prevalence (across sub-categories)					p value
			Drink much less alcohol (N=79)	Drink slightly less alcohol (N=102)	No change (N=940)	Drink slightly more alcohol (N=267)	Drink much more alcohol (N=77)	
Age (years)	18 to 29	161	6.8	8.1	60.2	19.9	5.0	0.01
	30 to 39	403	6.2	6.9	59.1	20.1	7.7	
	40 to 49	204	3.9	5.4	57.4	21.6	11.8	
	50 to 59	250	4.0	5.6	69.2	18.8	2.4	
	60 to 69	258	7.4	9.7	65.5	15.1	2.3	
	70 and older	189	3.2	5.8	77.2	12.7	1.1	
Living situation	Live alone	298	5.7	7.4	69.8	12.4	4.7	0.06
	Live with someone else	1167	5.3	6.9	62.7	19.7	5.4	
Household income (year)	<$40,000	169	8.3	2.4	70.4	13.6	5.3	0.06
	40,000 to 79,000	339	5.0	8.0	67.6	15.6	3.8	
	$80,000 to $119,000	357	5.3	7.3	62.7	19.3	5.3	
	$120,000 and over	416	4.3	7.9	58.7	22.4	6.7	
	Prefer not to answer	184	6.0	6.5	67.4	15.8	4.3	
Change in employment status	No change	148	3.4	10.1	60.8	20.9	4.7	<0.01
	Unemployed	174	7.5	5.2	54.6	23.6	9.2	
	Newly employed	54	5.6	14.8	46.3	27.8	5.6	
	Student / retired	362	5.2	8.0	71.8	12.7	2.2	
	Working from home	378	6.1	6.6	58.5	20.1	8.7	
	Other	349	4.6	4.6	71.3	16.6	2.9	
Residence	Urban	714	6.6	6.4	62.0	19.0	5.9	0.13
	Suburban	551	4.2	8.3	64.1	18.1	5.3	
	Rural	200	4.5	5.0	72.0	15.5	3.0	

Table S5. Changes in drinking status by measures of anxiety, depression, loneliness, and hopefulness among men

Independent variable		Total (N)	Prevalence (across sub-categories)					p value
			Drink much less alcohol (N=79)	Drink slightly less alcohol (N=102)	No change (N=940)	Drink slightly more alcohol (N=267)	Drink much more alcohol (N=77)	
Anxiety (GAD-7 score)	Low (0 to 4)	851	4.9	6.5	72.9	13.7	2.0	<0.01
	Mild to moderate (5 to 14)	517	6.4	7.7	54.2	23.0	8.7	
	Severe (15 or greater)	97	4.1	7.2	41.2	32.0	15.5	
Number of days feeling depressed	None	890	5.2	7.2	71.5	13.5	2.7	<0.01
	1 to 2	332	7.5	4.8	56.3	23.8	7.5	
	3 to 4	170	2.9	10.0	47.6	30.6	8.8	
	5 to 7	73	4.1	6.8	49.3	21.9	17.8	
Number of days feeling lonely	None	844	5.3	6.0	71.2	14.8	2.6	<0.01
	1 to 2	322	5.3	7.5	61.5	19.3	6.5	
	3 to 4	204	5.4	10.3	46.1	28.9	9.3	
	5 to 7	95	6.3	6.3	49.5	22.1	15.8	
Number of days feeling hopeful about the future	None	315	6.7	5.1	66.7	15.6	6.0	0.39
	1 to 2	421	5.0	7.4	62.5	20.2	5.0	
	3 to 4	460	6.3	7.4	61.5	19.8	5.0	
	5 to 7	269	3.0	7.8	68.4	15.6	5.2	

Table S6. Changes in drinking status by demographic measures among women

Independent variable		Total (N)	Prevalence (across sub-categories)					p value
			Drink much less alcohol (N=92)	Drink slightly less alcohol (N=69)	No change (N=988)	Drink slightly more alcohol (N=251)	Drink much more alcohol (N=61)	
Age (years)	18 to 29	388	5.9	5.9	65.7	18.0	4.4	0.01
	30 to 39	754	5.4	6.9	61.5	19.0	7.2	
	40 to 49	421	6.7	4.5	59.1	21.1	8.6	
	50 to 59	496	4.4	5.0	70.4	17.1	3.0	
	60 to 69	533	7.9	6.9	65.7	17.1	2.4	
	70 and older	360	4.4	4.7	76.4	12.8	1.7	
Living situation	Live alone	613	6.9	5.5	69.7	13.4	4.6	0.02
	Live with someone else	2339	5.6	5.9	64.8	18.9	4.8	
Household income (year)	<$40,000	361	8.9	1.9	71.2	12.7	5.3	<0.01
	40,000 to 79,000	701	5.7	6.0	67.8	17.1	3.4	
	$80,000 to $119,000	655	5.2	6.3	63.8	20.2	4.6	
	$120,000 and over	755	4.0	7.2	61.3	21.3	6.2	
	Prefer not to answer	480	7.5	6.0	68.5	13.5	4.4	
Change in employment status	No change	278	5.0	7.2	67.3	17.3	3.2	<0.01
	Unemployed	330	6.4	5.8	60.6	18.8	8.5	
	Newly employed	120	5.8	8.3	56.7	21.7	7.5	
	Student / retired	830	6.3	5.4	71.2	14.8	2.3	
	Working from home	747	5.6	7.0	58.9	21.2	7.4	
	Other	647	5.6	4.2	70.5	16.5	3.2	
Residence	Urban	1379	7.8	5.9	62.9	18.4	4.9	<0.01
	Suburban	1094	4.3	6.0	67.1	17.6	5.0	
	Rural	479	3.8	5.2	71.0	16.3	3.8	

Table S7. Changes in drinking status by measures of anxiety, depression, loneliness, and hopefulness among women

Independent variable		Total (N)	Prevalence (across sub-categories)					p value
			Drink much less alcohol (N=92)	Drink slightly less alcohol (N=69)	No change (N=988)	Drink slightly more alcohol (N=251)	Drink much more alcohol (N=61)	
Anxiety (GAD-7 score)	Low (0 to 4)	1564	5.6	5.2	74.4	13.1	1.7	<0.01
	Mild to moderate (5 to 14)	1138	6.5	6.8	56.7	22.8	7.3	
	Severe (15 or greater)	250	4.4	5.6	53.6	24.0	12.4	
Number of days feeling depressed	None	1632	5.6	5.9	72.7	13.5	2.3	<0.01
	1 to 2	743	7.0	5.2	60.3	21.1	6.3	
	3 to 4	394	4.6	7.6	52.5	27.7	7.6	
	5 to 7	183	6.0	3.8	55.2	20.8	14.2	
Number of days feeling lonely	None	1558	5.4	6.0	71.6	14.6	2.3	<0.01
	1 to 2	724	6.5	5.5	65.1	17.5	5.4	
	3 to 4	423	5.9	6.6	52.7	26.7	8.0	
	5 to 7	247	6.5	4.5	53.4	22.7	13.0	
Number of days feeling hopeful about the future	None	621	8.2	4.2	65.5	16.3	5.8	<0.01
	1 to 2	927	4.7	6.6	62.4	21.1	5.2	
	3 to 4	865	6.0	6.4	66.2	17.2	4.2	
	5 to 7	539	4.6	5.8	71.2	14.5	3.9	

Table S8. Adjusted Ordered Odds Ratios for changes in alcohol consumption by demographic measures (while controlling for survey wave)

Independent variable		Ordered odds ratio	(95% CI)	p value
Gender	Male	1.12	(0.96, 1.30)	0.15
	Female	REF	-	-
	Other	1.60	(0.72, 3.54)	0.25
Age (years)	18 to 29	REF	-	-
	30 to 39	1.16	(0.89, 1.50)	0.26
	40 to 49	1.47	(1.10, 1.96)	<0.01
	50 to 59	1.05	(0.80, 1.39)	0.72
	60 to 69	1.07	(0.80, 1.43)	0.66
	70 and older	1.22	(0.87, 1.71)	0.24
Living situation	Live with someone else	REF	-	-
	Live alone	1.27	(1.04, 1.56)	0.02
Household income (year)	<$40,000	REF	-	-
	40,000 to 79,000	1.06	(0.81, 1.38)	0.68
	$80,000 to $119,000	1.29	(0.97, 1.70)	0.08
	$120,000 and over	1.48	(1.11, 1.97)	<0.01
	Prefer not to answer	1.00	(0.74, 1.34)	0.97
Change in employment status	No change	REF	-	-
	Newly employed	1.25	(0.80, 1.96)	0.33
	Unemployed	1.25	(0.80, 1.96)	0.33
	Student / retired	1.02	(0.75, 1.39)	0.88
	Working from home	1.33	(1.00, 1.78)	0.05
	Other	1.11	(0.83, 1.49)	0.48
Residence	Rural	REF	-	-
	Urban	0.95	(0.76, 1.18)	0.63
	Suburban	0.87	(0.70, 1.09)	0.23
Survey wave	Wave 2	0.96	(0.80, 1.15)	0.64
	Wave 3	0.93	(0.77, 1.11)	0.42
	Wave 4	REF	-	-

* Ordinal categorization of changes in alcohol consumption (lowest to highest): drank “much less alcohol”, drank “slightly less alcohol", experienced "no change" in alcohol consumption, drank “slightly more alcohol”, or drank “much more alcohol” compared to before the start of the COVID-19 pandemic

* All models included measures of anxiety and depression (see Table S9)

Table S9. Adjusted Ordered Odds Ratios for changes in alcohol consumption by measures of anxiety, depression, loneliness and hopefulness (while controlling for survey wave)

Independent variable		Ordered odds ratio*	(95% CI)	p value
Anxiety (GAD-7 score)	Low (0 to 4)	REF	-	-
	Mild to moderate (5 to 14)	1.33	(1.09, 1.62)	<0.01
	Severe (15 or greater)	1.53	(1.07, 2.20)	0.02
Number of days feeling depressed	None	REF	-	-
	1 to 2	1.26	(1.02, 1.55)	0.03
	3 to 4	1.40	(1.04, 1.89)	0.03
	5 to 7	1.41	(0.91, 2.17)	0.13
Number of days feeling lonely	None	REF	-	-
	1 to 2	1.06	(0.87, 1.30)	0.55
	3 to 4	1.48	(1.13, 1.93)	<0.01
	5 to 7	1.61	(1.12, 2.31)	<0.01
Number of days feeling hopeful about the future	None	0.85	(0.66, 1.09)	0.19
	1 to 2	0.97	(0.77, 1.23)	0.82
	3 to 4	0.89	(0.71, 1.12)	0.32
	5 to 7	REF	-	-

* Ordinal categorization of changes in alcohol consumption (lowest to highest): drank “much less alcohol”, drank “slightly less alcohol", experienced "no change" in alcohol consumption, drank “slightly more alcohol”, or drank “much more alcohol” compared to before the start of the COVID-19 pandemic

* All models included demographics measures (see Table S8)

Table S10. Log likelihood ratio tests for effect modification by gender

Independent variable*	Log likelihood (model without interaction term)	Log likelihood (model with interaction term)	c^2 value	degrees of freedom (c^2 test)	p-value
Age (years)	-3022.2	-3018.7	6.98	5	0.222
Living situation	-3022.2	-3021.8	0.96	1	0.327
Household income (per year)	-3022.2	-3021.0	2.43	4	0.657
Changes in employment status	-3022.2	-3020.0	4.43	2	0.109
Anxiety (GAD-7 score)	-3022.2	-3020.0	4.43	2	0.109
Number of days feeling depressed	-3022.2	-3021.0	2.48	3	0.479
Number of days feeling hopeful about the future	-3022.2	-3021.1	2.26	3	0.521

* Effect modification was tested for men and women only (i.e., these analyses excluded people who did not identify as either a man or a woman)