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Sociodemographic changes in emergency department visits due to alcohol during COVID-19

Daniel T. Myran^{a,b,c,*}, Nathan Cantor^a, Michael Pugliese^c, Tavis Hayes^d, Robert Talarico^c, Paul Kurdyak^{e,f,g}, Danial Qureshi^a, Peter Tanuseputro^{a,c,h,i}

^a Clinical Epidemiology Program, Ottawa Hospital Research Institute, Ottawa, Ontario, Canada

^b Department of Family Medicine, University of Ottawa, Ottawa, Ontario, Canada

^c ICES, Ottawa, Ontario, Canada

^d School of Epidemiology and Public Health, University of Ottawa, Ottawa, Ontario, Canada

^e Mental Health and Addictions Research Program, ICES, Toronto, Ontario, Canada

^f Department of Psychiatry, University of Toronto, Toronto, Ontario, Canada

^g Institute for Mental Health Policy Research, Centre for Addiction and Mental Health, Toronto, Ontario, Canada

^h Bruyère Research Institute, Ottawa, Ontario, Canada

ⁱ Department of Medicine, University of Ottawa, Ottawa, Ontario, Canada

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ABSTRACT

Introduction: Little detailed sociodemographic information is available about how alcohol use and associated health care visits have changed during COVID-19. Therefore, we assessed how rates of emergency department (ED) visits due to alcohol have changed during COVID-19 by age and sex and for individuals living in urban and rural settings and low and high-income neighborhoods.

Methods: Our cohort included 13,660,516 unique Ontario residents between the ages of 10–105. We compared rates and characteristics of ED visits due to alcohol, identified using ICD-10 codes, from March 11–August 31 2020 to the same period in the prior 3 years. We used negative binomial regressions to examine to examine changes in visits during COVID-19 after accounting for temporal and seasonal trends.

Results: During COVID-19, the average monthly rate of ED visits due to alcohol decreased by 17.2 % (95 % CI -22.7, -11.3) from 50.5–40.9 visits per 100,000 individuals. In contrast, the proportion of all-cause ED visits due to alcohol increased by 11.4 % (95 % CI 7.7, 15.3) from 15.0 visits to 16.3 visits per 1000 all cause ED visits. Changes in ED visits due to alcohol were similar for men in women. Decreases in visits were larger for younger adults compared to older adults and pre-COVID-19 disparities in rates of ED visits due to alcohol between urban and rural settings and low and high-income neighborhoods widened. ED visits related to harms from acute intoxication showed the largest declines during COVID-19, particularly in younger adults and urban and high-income neighborhoods.

Conclusion: ED visits due to alcohol decreased during the first six months of COVID-19, but to a lesser extent than decreases in all-cause ED visits. Our data suggest a widening of geographic and income-based disparities in alcohol harms in Ontario during COVID-19 which may require immediate and long-term interventions to mitigate.

1. Introduction

Since the declaration of the novel coronavirus disease 2019 (COVID-19) pandemic, there have been growing concerns that alcohol consumption and harms have increased (Rehm et al., 2020). Findings from prior major social and economic upheavals support that the increased

stress, financial uncertainty, and unemployment experienced during COVID-19 could result in greater alcohol use and related health and social consequences (Acuff et al., 2020; de Goeij et al., 2015; North et al., 2011). Alcohol-specific policies enacted during COVID-19, including the designation of liquor stores as an essential service and allowing home delivery of alcohol from bars and restaurants, may also promote alcohol

* Corresponding author at: Ottawa Hospital Research Institute, 1053 Carling Avenue, Box 693, Ottawa, Ontario, K1Y4E9, Canada.

E-mail address: dmyra088@uottawa.ca (D.T. Myran).

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use when combined with disrupted routines and social isolation during periods of lockdown (Acuff et al., 2020; Hobin and Smith, 2020; Neufeld et al., 2020). Several surveys from Canada and the United States have found net increases in self-reported alcohol use during the pandemic (Canadian Centre on Substance Abuse and Addiction, 2020; Canadian Red Cross, 2020; Pollard et al., 2020). Alcohol sales, which predict population-level alcohol use, have also increased in Ontario during COVID-19 (Zipursky et al., 2021). While surveys from Europe have found more modest increases (Rossow et al., 2021) and decreases (Manthey et al., 2021) in self-reported alcohol use, results from all regions suggest that specific groups of vulnerable individuals, such as those with concurrent mental health disorders or pre-COVID-19 patterns of heavy drinking, have experienced increases in alcohol use during the pandemic (Rossow et al., 2021; Statistics Canada, 2020a). Importantly, while multiple studies have examined changes in alcohol use few have examined how health care visits due to alcohol have changed during COVID-19, and if these changes in health harms differ by sociodemographic factors.

Emergency department (ED) visits due to alcohol have been used to track the health system burden from alcohol in Canada and internationally (Stockwell et al., 2021). Studies of ED visits due to alcohol pre-COVID-19 have found unique patterns of alcohol harms among subgroups, including individuals of lower socioeconomic status, rural individuals, younger adults and women (Myran et al., 2019; White et al., 2018). Despite evidence suggesting that alcohol use has increased in Canada and the US during COVID-19, initial reports suggest there have been reductions in visits due to alcohol during the early phase of COVID-19 (Smalley et al., 2020; Zipursky et al., 2021). One study examining ED visits due to alcohol intoxication across 141 emergency departments in the United States during COVID-19 found that these visits had decreased by 27.5 % (Smalley et al., 2020). Another study set in Ontario found that monthly rates of ED visits due to alcohol declined by 23 % relative to before the pandemic (Zipursky et al., 2021). However, to date, no studies have examined whether changes in alcohol visits during COVID-19 have varied by age and sex, by detailed type of alcohol harm (e.g. intoxication vs alcoholic liver disease), or if changes vary in specific populations (e.g. lower income and rural individuals).

To better understand how alcohol-related harms have changed due to COVID-19, we compared ED visits due to alcohol and all-cause ED visits in Ontario, the largest province in Canada, before and during the first 6 months of COVID-19. We hypothesized that ED visits due to alcohol would decrease during COVID-19 but would increase as a proportion of all-cause ED visits, given prior reports of large declines in all-cause acute care use during the early phases of the pandemic (CIHI, 2020). We further hypothesized that groups of individuals historically found to have a higher burden of alcohol-related ED visits in Ontario, such as low-income and rural individuals and older males, would show the smallest decreases in visits due to alcohol during the pandemic (Myran et al., 2019; Myran et al., 2021).

2. Methods

2.1. Study design and population

We conducted a retrospective, population-level study in Ontario, Canada using linked administrative data collected from the province's universal health care system (OHIP). All Ontario residents who were between the ages of 10 and 105 and were alive and living in Ontario between 2017 and 2020 were eligible for inclusion in the study. Individuals were assessed on January 1 of each year and excluded from that year if they were missing data on age, sex, or had not been continuously eligible for OHIP in the two years prior to index visit. ED visits were captured in our study if they occurred between March 11th and August 31st each year, with the years 2017–2019 defined as “pre-COVID-19” and 2020 defined as “COVID-19”. In total, our study included 12,731,498 unique individuals pre-COVID-19 and 12,999,775

unique individuals during COVID-19, after excluding 5.7 % and 3.6 % of eligible Ontarians pre- and during COVID-19, respectively for missing demographic information or not meeting the OHIP eligibility requirements.

2.2. Data sources and covariates

We used de-identified health administrative databases at ICES (formerly the Institute for Clinical Evaluative Sciences) linked at the individual level using encrypted health card numbers as unique identifiers. These databases are made available through a data sharing agreement with the Government of Ontario's Ministry of Health. The following databases were linked at the individual level: 1) National Ambulatory Care Reporting System (NACRS), to capture all ED visits; 2) Registered Persons Database (RPD), to capture demographic data such as age, sex, and postal code information; and 3) Statistics Canada Census Data, to capture income quintile and rurality via postal codes.

We categorized individuals into 6 age groups (10–18, 19–29, 30–39, 40–49, 50–59 and 60+) as representing groups with potentially different experiences of the pandemic and to capture underage drinking (legal age of consumption is 19 in Ontario). Rural areas were those located in a town or municipality outside of the commuting zone of census metropolitan areas (CMA, population of 100,000 or more) or census agglomerations (CA, population of 10,000 or more) (Statistics Canada, 2019). Income quintiles were based off the Income Per Person Equivalent (QAIPPE) measure from Statistics Canada. QAIPPE is based on the average before tax income, which is adjusted for household size and is relative to other neighborhoods either within the same CMA or CA, or in rural Ontario (Statistics Canada, 2013). We report socio-demographic information captured at the index ED visit due to alcohol in both the pre- and during COVID-19 periods.

2.3. Outcomes

Our primary outcome was an ED visit due to alcohol, defined using the Canadian Institute for Health Information's (CIHI) indicator “Hospital Stays for Harms Caused by Substance Use” (Canadian Institute for Health Information, 2019). ED visits were classified as due to alcohol when a diagnostic code (International Classification of Diseases 10) from the indicator was listed as the main reason or contributing reason for a visit. The CIHI indicator captures a variety of alcohol harms including visits related to intoxication and withdrawal, alcohol liver disease and accidental or intentional alcohol poisoning. For a complete list of alcohol-related harms measured in this study, see Appendix 1. We report the overall rate of ED visits due to alcohol as well as rates by specific causes (ICD-10 codes). In order to capture changes in health system use during COVID-19 we also examined “all-cause” or ED visits for any reason.

2.4. Statistical analyses

We present descriptive statistics including frequencies, proportions and standardized differences (Austin, 2009) to characterize and compare the rates of ED visits due to alcohol across age groups, sex and neighborhood income quintiles. We calculated monthly counts of ED visits in the time period before (March – August in 2017, 2018 and 2019) and during (March -August 2020) the pandemic. We then calculated average monthly rates of visits per 100,000 individuals and per 1000 all-cause ED visits, with the denominator for rates being a) all eligible Ontario residents of each corresponding year and b) the total number of all-cause ED visits each month.

We used negative binomial regression models where the unit of analysis was the monthly count of ED visits due to alcohol. We included a linear covariate for calendar year to control for temporal trends, and a categorical indicator variable for month to adjust for seasonal variation. We included a binary indicator for months that occurred during the

COVID-19 pandemic and the coefficient was interpreted as the average change in visits during COVID-19. We offset our regressions by either the log of the total population of Ontario in each month (to examine changes in visits per capita) or by the log of the total number of all-cause ED visits in Ontario each month (to examine changes in visits as a proportion of all-cause ED visits). We then ran separate models with an interaction term between the COVID-19 variable and one of the following covariates to test for subgroup differences: men vs women, age <30 vs 30+, urban vs rural, and highest (Q5) vs lowest neighborhood income quintile (Q1). All analyses were performed using SAS software version 9.4.3.

3. Results

Table 1 summarizes the characteristics, by sex, of all Ontario residents who visited the ED due to alcohol during three 6-month periods (March – August 2017–2019) pre-COVID ($N_{Men} = 39,492$, $N_{Women} = 22,247$) and during the first 6 months of COVID-19 ($N_{Men} = 13,167$, $N_{Women} = 6929$). In both men and women, the mean age at the first alcohol-related ED visit in the COVID-19 period was higher than in the three prior years. Men and women who had an ED visit due to alcohol were more likely to have multiple ED visits during the first six months of COVID-19 compared to the same six-month period in the three prior years.

Tables 2 and 3 compare the average rate of ED visits due to alcohol per 100,000 individuals (Table 2) and per 1000 all-cause ED visits (Table 3) before and during COVID-19. Overall, the average monthly rate of ED visits due to alcohol per 100,000 individuals decreased by 17.2 % (95 % CI -22.7, -11.3). There were no significant differences in the decreases in rates of visits due to alcohol during COVID-19 between men and women ($p = 0.43$) and by neighbourhood income ($p = 0.24$). There were differences in changes by age. Decreases in visits for those

under 30 (-30.9 %, 95 %CI -36.1 %, -25.2 %) were significantly different from decrease in those 30 and older (-13.1 %, 95 %CI -19.4, -6.3). Decreases also differed by geography where rates of ED visits due to alcohol among those living in urban settings decreased significantly by 17.3 % (95 %CI -23.3, -10.9) while rates did not change during COVID-19 in rural individuals. This resulted in a widening of the urban vs. rural disparity in rates of ED visits due to alcohol during COVID-19 ($RR_{Rural:Urban} = 1.53$, 95 % CIs: 1.50, 1.57) compared to pre-pandemic differences ($RR_{Rural:Urban} = 1.29$, 95 % CIs: 1.27, 1.30).

The proportion of all-cause ED visits due to alcohol increased significantly in the 6 months following the declaration of the pandemic by 11.4 % (95 % CI 7.7, 15.3) (see Table 3). There was no significant difference in changes between men and women ($p_{interaction} = 0.22$). The proportion of all-cause ED visits due to alcohol increased during COVID-19 by 13.3 % (95 %CI 8.5, 18.3) for those aged 30 and older, which was significantly greater than the increase of 5.0 % (95 %CI 0.1, 10.3) in those younger than 30. Geographic and income-based disparities in the proportion of all-cause ED visits due to alcohol increased significantly during COVID-19. The proportion of all-cause ED visits attributed to alcohol increased by 39.5 % (32.3, 47.0) among rural individuals, compared to an increase of 9.5 % (5.0, 14.3) in those living in urban areas.

Tables 4 and 5 compare the average monthly rates of alcohol-related ED visits (with 95 % CIs) by ICD-10 codes before and during COVID-19, stratified by neighbourhood income quintiles (Q1 and Q5, Table 4) and rural and urban regions (Table 5). There was wide variation in changes based on the type of alcohol harm and between low and high-income and urban and rural regions. Overall, the largest absolute and relative decreases in the type of visit was for acute intoxication, the most common reason for visit pre and during COVID-19. However, the relative percent decrease in rates of visits due to intoxication dependence during

Table 1

Characteristics of Ontario residents who visited the emergency department for visits due to alcohol use between March 11 and August 31 in the three six-month periods prior to COVID-19 ($n = 61,738$) and during the first six months of COVID-19 ($n = 20,096$).

Characteristics [^]	Women			Men		
	Pre-COVID (March 11- August 31 2017–2019)	During COVID-19 (March 11 - August 31 2020)	Standardized difference	Pre-COVID (March 11- August 31 2017–2019)	During COVID-19 (March 11 - August 31 2020)	Standardized difference
Number of people with an ED visits due to alcohol	22,247	6929	–	39,492	13,167	–
Mean Number of ED visits due to alcohol during March 11 - August 31 in year of event (Mean ± SD)	1.31 ± 1.33	1.49 ± 1.72	0.12	1.39 ± 1.65	1.64 ± 2.39	0.12
Number of ED visits due to alcohol in year of event, No. (%)						
1 visit	19,003 (85.4 %)	5530 (79.8 %)	0.15	32,854 (83.2 %)	10,223 (77.6 %)	0.14
2 visits	1976 (8.9 %)	780 (11.3 %)	0.08	3885 (9.8 %)	1563 (11.9 %)	0.07
3 visits	635 (2.9 %)	281 (4.1 %)	0.07	1263 (3.2 %)	574 (4.4 %)	0.06
4 visits	262 (1.2 %)	114 (1.6 %)	0.04	554 (1.4 %)	261 (2.0 %)	0.04
5+ visits	371 (1.7 %)	224 (3.2 %)	0.10	936 (2.4 %)	546 (4.1 %)	0.10
Age in years (Mean ± SD)	38.23 ± 17.85	40.50 ± 17.25	0.13	43.02 ± 17.59	45.27 ± 16.64	0.13
Age categories, No. of Visits (%)						
10–18 years	2227 (10.0 %)	445 (6.4 %)	0.13	2111 (5.3 %)	369 (2.8 %)	0.13
19–29 years	7145 (32.1 %)	1887 (27.2 %)	0.11	9505 (24.1 %)	2522 (19.2 %)	0.12
30–39 years	3529 (15.9 %)	1343 (19.4 %)	0.09	6554 (16.6 %)	2442 (18.5 %)	0.05
40–49 years	2863 (12.9 %)	1062 (15.3 %)	0.07	5720 (14.5 %)	2114 (16.1 %)	0.04
50–59 years	3266 (14.7 %)	1053 (15.2 %)	0.01	7625 (19.3 %)	2797 (21.2 %)	0.05
60+ years	3217 (14.5 %)	1139 (16.4 %)	0.05	7977 (20.2 %)	2923 (22.2 %)	0.05
Geography, No. of Visits (%)						
Rural	3019 (13.6 %)	1114 (16.1 %)	0.07	4987 (12.6 %)	1878 (14.3 %)	0.05
Urban	19,073 (85.7 %)	5766 (83.2 %)	0.07	34,201 (86.6 %)	11,191 (85.0 %)	0.05
Income Quintile, No. of Visits (%)						
1 (lowest)	6912 (31.1 %)	2342 (33.8 %)	0.06	12,902 (32.7 %)	4519 (34.3 %)	0.03
2	4511 (20.3 %)	1388 (20.0 %)	0.01	8342 (21.1 %)	2783 (21.1 %)	0.01
3	3765 (16.9 %)	1140 (16.5 %)	0.01	6858 (17.4 %)	2251 (17.1 %)	0.01
4	3457 (15.5 %)	1017 (14.7 %)	0.02	5755 (14.6 %)	1849 (14.0 %)	0.02
5 (highest)	3428 (15.4 %)	987 (14.2 %)	0.03	5299 (13.4 %)	1657 (12.6 %)	0.02

[^] Individuals with multiple visits in a time period contribute once to that time period with characteristics captured on the first visit.

Table 2

Average monthly rates of alcohol-related ED visits (per 100,000 Ontario residents and per 1,000 all-cause ED visits) by demographic information, stratified by pre- and during COVID-19.

Rate of ED Visits Due to Alcohol Per 100,000 Individuals			
Variable	Pre-COVID-19 (2017-2019)	During COVID-19 (2020)	Adj. Percent Change (95 % CI) ^A
Total	50.5	40.9	-17.2 (-22.7, -11.3)
Sex			
Women	32.7	25.9	-16.2 (-21.5, -10.6)
Men	69.0	56.4	-19.0 (-24.3, -13.4)
Age			
10-18 years*	19.9	10.5	-46.9 (-52.0, -41.2)
19-29 years	72.0	51.8	-27.1 (-32.6, -21.3)
30-39 years	65.5	57.2	-10.8 (-17.4, -3.7)
40-49 years	55.3	48.7	-10.0 (-16.8, -2.7)
50-59 years	61.0	50.5	-15.7 (-22.0, -9.0)
60+ years	32.3	28.2	-11.2 (-17.8, -4.0)
Geography^C			
Urban*	48.8	38.5	-17.3 (-23.3, -10.9)
Rural	62.7	59.1	-1.3 (-9.1, 7.1)
Neighborhood Income Quintile^C			
1 (lowest)	94.9	79.0	-14.2 (-19.8, -8.3)
2	52.1	43.4	-14.0 (-19.7, -7.8)
3	39.6	32.6	-14.9 (-20.7, -8.7)
4	34.8	26.5	-21.5 (-27.0, -15.7)
5 (highest)	30.4	23.6	-20.2 (-25.8, -14.1)

^AAdjusted percent changes were obtained from rate ratios comparing average monthly counts of visits due to alcohol (per capita) in the first 6 months following the declaration of the COVID-19 pandemic to the same 6-month periods in 2017–2019. Analyses are adjusted for month and yearly trend.

^BAdjusted percent changes were obtained from rate ratios comparing average monthly count of visits (per total all-cause ED visits) in the first 6 months following the declaration of the COVID-19 pandemic to the same 6-month periods in 2017–2019. Analyses are adjusted for month and yearly trend.

^CIndividuals with missing geography and neighbourhood income are not shown. * P < 0.001, ** P < 0.05 for subgroup difference (interaction between COVID-19 and: Women vs. Men; < 30 vs. 30+; Urban vs. Rural, and Q1 vs. Q5).

COVID-19 differed significantly by geography and income, with smaller declines in rural regions and low-income neighbourhoods compared to urban and high-income neighbourhoods. Alcohol withdrawal, the third most common reason for an ED visit due to alcohol, experienced smaller declines and increased significantly during COVID-19 in rural regions.

Changes in cause of visits also differed by age. For example, there was a significant difference ($p_{\text{interaction}} < 0.001$) by age in changes in visits related to acute intoxication, which declined by 21.8 % (95 % CI -28.4, -14.5) among individuals older than 30 but by 41.7 % (95 % CI -46.9, -36.0) in individuals younger than 30. Similarly, decreases in visits for harmful alcohol use were also significantly greater ($p_{\text{interaction}} < 0.001$) among those less than 30 (-25.1 %, 95 % CI -30.2, -19.2) compared to older than 30 (-9.6 %, 95 % CI, -15.1, -3.8).

4. Discussion

Despite considerable speculation about how alcohol use and health care visits related to alcohol would change during COVID-19, there have been few studies on this topic. In this population-level study, capturing nearly 13 million people in Canada's most populous province, we found that during COVID-19, while the number of ED visits due to alcohol declined by 17.2 % relative to the prior 3 years, they increased as a proportion of all-cause ED visits. Changes in ED visits due to alcohol were similar in men and women but differed markedly by age, rurality and neighborhood income. Adults less than 30 had the largest decreases in visits while middle-aged adults had the smallest decreases. Decreases

Table 3

Average monthly rates of alcohol-related ED visits (per 100,000 Ontario residents and per 1,000 all-cause ED visits) by demographic information, stratified by pre- and during COVID-19.

Rate of ED Visits Due to Alcohol Per 1,000 All-Cause ED Visits			
Variable	Pre-COVID-19 (2017-2019)	During COVID-19 (2020)	Adj. Percent Change (95 % CI) ^A
Total	15.0	16.3	11.4 (7.7, 15.3)
Sex			
Women	9.3	10.1	8.8 (5.3, 12.4)
Men	21.6	23.0	11.9 (7.8, 16)
Age			
10-18 years**	7.2	7.4	3.3 (-5, 12.3)
19-29 years	20.9	19.9	-2.5 (-7.3, 2.7)
30-39 years	21.7	24.2	14.1 (8.4, 20.1)
40-49 years	20.7	22.5	11.4 (5.8, 17.4)
50-59 years	20.8	21.5	6.1 (0.9, 11.7)
60+ years	7.2	8.7	23.2 (16.9, 29.7)
Geography^C			
Urban*	15.8	16.6	9.5 (5.0, 14.3)*
Rural	11.0	14.6	39.5 (32.3, 47.0)
Neighborhood Income Quintile^C			
1 (lowest)*	22.2	24.4	12.7 (8.7, 17.0)
2	14.6	16.5	16.0 (11.4, 20.9)
3	12.0	13.5	15.7 (10.7, 20.9)
4	11.6	11.9	4.9 (0.2, 9.9)
5 (highest)	11.4	11.5	3.2 (-1.6, 8.2)

^AAdjusted percent changes were obtained from rate ratios comparing average monthly counts of visits due to alcohol (per capita) in the first 6 months following the declaration of the COVID-19 pandemic to the same 6-month periods in 2017–2019. Analyses are adjusted for month and yearly trend.

^BAdjusted percent changes were obtained from rate ratios comparing average monthly count of visits (per total all-cause ED visits) in the first 6 months following the declaration of the COVID-19 pandemic to the same 6-month periods in 2017–2019. Analyses are adjusted for month and yearly trend.

^CIndividuals with missing geography and neighbourhood income are not shown. * P < 0.001.

** P < 0.05 for subgroup difference (interaction between COVID-19 and: Women vs. Men; < 30 vs. 30+; Urban vs. Rural, and Q1 vs. Q5).

in visits in rural and low-income neighborhoods were smaller than declines in urban and higher income regions, leading to increases in the relative disparities in the burden of ED visits due to alcohol between these groups. Visits most likely related to acute alcohol use (e.g. intoxication, poisonings and harmful use) showed the largest decreases, while visits likely related to more chronic alcohol use (e.g. withdrawal and alcoholic liver disease) showed smaller decreases, and in some subgroups increased during COVID-19.

Overall, ED visits due to alcohol decreased during COVID-19 in Ontario but to a lesser extent than general ED use. The collective impact of this finding was alcohol being responsible for a greater relative burden on the health care system during COVID-19. Our findings are further supported by surveys reporting increases in alcohol use and alcohol sales during the pandemic in Ontario (Canadian Centre on Substance Abuse and Addiction, 2020; Canadian Red Cross, 2020; Zipsursky et al., 2021). It is likely that despite greater population-level alcohol consumption, alcohol related-ED visits declined during COVID-19 due to a reluctance to seek hospital-based care over concerns such as of exposure to COVID-19 or a civic sense of duty to avoid burdening the health system. Indeed, there have been well-documented declines in general ED use in Canada (CIHI, 2020). These declines in visits included very high-acuity causes (e.g. myocardial infarctions) where visits were anticipated to be less “avoidable” and susceptible to concerns over seeking care (CIHI, 2020; Heart and Stroke Foundation, 2020). In addition, hospitalizations due to alcohol, which likely represent health care visits which are less avoidable than ED visits due to alcohol, have increased during COVID-19 in Canada (CIHI, 2021). Together, these findings suggest that alcohol use resulting in health

Table 4

Average monthly rates (per 100,000 people) of visits to the emergency department due to alcohol by diagnostic codes for by lowest (Q1) and highest (Q5) neighbourhood income in the 3 years prior to COVID-19 compared to during COVID-19.

Alcohol-Related Harms (ICD-10 Codes)	Q1 (Lowest Quintile) rates per 100,000 (95 % CIs)			Q5 (Highest Quintile) rates per 100,000 (95 % CIs)		
	Pre-COVID-19	During COVID-19	Adj. Percent change (95 % CIs) ^A	Pre-COVID-19	During COVID-19	Adj. Percent change (95 % CIs)
Acute intoxication	43.5	32.8	-22.9% (-28.0, -17.4)	13.0	8.5	-32.8% (-38.2, -26.8)
Harmful use	23.8	20.2	-12.1% (-18.2, -5.4)	6.9	5.7	-13.9% (-21.7, -5.2)
Alcohol dependence*	8.4	6.7	-23.8% (-31.4, -15.3)	3.1	2.0	-35.7% (-44.3, -25.8)
Alcohol withdrawal*	14.5	14.8	+7.8% (-0.1, 16.3)	5.1	4.8	-1.0% (-10.5, 9.5)
Mental/behavioural disorders due to use of alcohol, other	1.7	2.2	+52.3% (27.1, 82.5)	0.6	0.7	+40.8% (9.5, 81.2)
Alcoholic liver disease	3.0	3.1	+8.1% (-4.6, 22.5)	1.3	1.5	+21.9% (3.4, 43.7)
Alcoholic gastritis	1.1	1.0	-12.7% (-29.0, 7.3)	0.4	0.4	-0.01% (-26.6, 36.2)
Accidental or intentional poisoning by alcohol	2.6	1.9	-18.1% (-28.9, -5.7)	1.0	0.9	-5.5% (-22.4, 15.1)
Other medical conditions due to alcohol	3.8	3.1	-13.1% (-23.4, -1.5)	1.5	1.4	-2.4% (-17.5, 15.3)

^A Adjusted percent changes were obtained from rate ratios comparing average monthly counts of visits due to alcohol (per capita) in the first 6 months following the declaration of the COVID-19 pandemic to the same 6-month periods in 2017–2019. Analyses are adjusted for month and yearly trend. CIs: Confidence Intervals. See **Appendix 1** for a full list of ICD-10 codes for alcohol-related harms.

* $P < 0.001$, ** $P < 0.05$ for subgroup difference (interaction between COVID-19 and neighbourhood income Quintile).

Table 5

Average monthly rates (per 100,000 people) of visits to the emergency department due to alcohol by diagnostic codes for rural- and urban-dwelling individuals in the 3 years prior to COVID-19 compared to during COVID-19.

Alcohol-Related Harms (ICD-10 Codes)	Rural rates per 100,000 (95 % CIs)			Urban rates per 100,000 (95 % CIs)		
	Pre-COVID-19	During COVID-19	Adj. Percent change (95 % CIs) ^A	Pre-COVID-19	During COVID-19	Adj. Percent change (95 % CIs)
Acute intoxication**	27.9	24.8	-6.2% (-14.5, 2.7)**	21.6	14.8	-28.2% (-33.6, -22.3)
Harmful use*	13.4	12.6	-3.8% (-12.3, 5.6)*	12.0	10.0	-14.3% (-19.8, -8.5)
Alcohol dependence	6.3	4.9	-23.9% (-34.3, -11.8)	4.4	3.5	-22.1% (-29.8, -13.4)
Alcohol withdrawal**	10.6	12.0	+21.1% (9.7, 33.7)**	7.8	7.2	-1.3% (-8.2, 6.0)
Mental/behavioural disorders due to use of alcohol, other	0.8	1.0	+40.5% (5.5, 87.0)	1.0	1.2	+44.9% (27.0, 65.3)
Alcoholic liver disease	2.5	2.7	+12.0% (-6.6, 34.2)	1.9	2.0	+9.9% (-1.7, 22.9)
Alcoholic gastritis*	1.3	1.5	+22.2% (-3.8, 55.2)*	0.5	0.4	-21.2% (-33.7, -6.5)
Accidental or intentional poisoning by alcohol	1.4	1.2	-2.8% (-23.6, 23.5)	1.5	1.2	-9.3% (-18.2, 0.6)
Other medical conditions due to alcohol	2.2	2.1	+4.6% (-12.6, 25.3)	2.3	2.0	-5.4% (-12.4, 2.3)

^A Adjusted percent changes were obtained from rate ratios comparing average monthly counts of visits due to alcohol (per capita) in the first 6 months following the declaration of the COVID-19 pandemic to the same 6-month periods in 2017–2019. Analyses are adjusted for month and yearly trend. CIs: Confidence Intervals. See **Appendix 1** for a full list of ICD-10 codes for alcohol-related harms.

* $P < 0.001$.

** $P < 0.05$ for subgroup difference (interaction between COVID-19 and urban vs rural home address).

consequences has increased during COVID-19 and caused a relative increase in the burden on the health system during a period of already heightened stress.

We found that individuals under the age of 30 experienced much larger decreases in ED visits due to alcohol compared to those over 30. A major contributor to this finding was a larger decrease in presentations related to acute alcohol use (e.g. acute intoxication and harmful use) in those less than 30 compared with those aged 30+. This finding may be explained by restrictions against and closure of settings associated heavy drinking, including bars, universities and colleges and social gathering, which research has found are major sources of alcohol consumption in younger adults (Harford et al., 2002). The smaller decreases in older adults are consistent with survey results showing that adults aged 35–54 reported the largest net increases in alcohol use during COVID-19 (Statistics Canada, 2020b). Research has shown that pre-COVID-19, older adults consumed more alcohol at home than younger individuals (Treno et al., 2000), a trend which may have widened during COVID-19. Surveys have also found that parents with young children at home have reported greater heavy drinking during the pandemic, which in more extreme cases may be contributing to increased ED visits due to alcohol in older adults (The Centre for Addiction and Mental Health, 2020). Of

concern, alcohol contributes to multiple chronic conditions and declines in acute alcohol-related presentations, particularly in younger adults, may be masking harms from increased alcohol use at the population-level which may present with consequent health and social costs well beyond the pandemic (Canadian Centre on Substance Use and Addiction, 2020).

At the start of the pandemic, much of the debate about designating off-premise alcohol stores (e.g. liquor stores) as an essential service revolved around needing to prevent individuals with alcohol use disorders (AUD) entering withdrawal (Acuff et al., 2020; Hobin and Smith, 2020; Neufeld et al., 2020). We observed that visits related to alcohol withdrawal had some of the smallest relative decreases during COVID-19, and relatively increased in individuals living in rural and low-income neighbourhoods. It is important to note that these large relative increases represent relatively small absolute differences. Therefore, it is difficult to know whether these changes represent clinically meaningful differences over time. Nonetheless, there are some potential reasons for these relative increases in alcohol withdrawal. It is possible these visits may represent individuals with pre-COVID-19 AUD experiencing withdrawal from limited access to alcohol; however, access to alcohol stores was maintained and even expanded (with home

delivery of alcohol from bars and restaurants being permitted) in Ontario during COVID-19 (Hobin and Smith, 2020). Conversely, increases in these visits may represent individuals who have developed harmful patterns of drinking during the pandemic and are subsequently attempting to cut back on their use. This possibility could signal a lack of access to addiction medicine services during the pandemic and harmful patterns of drinking with long term health implications post COVID-19.

We found that income-based disparities in alcohol-related harms have increased during COVID-19, which may be the result of drinking as a coping mechanism for higher levels of pandemic-related stressors in lower-income individuals. In Canada, COVID-19 has disproportionately impacted individuals of lower socioeconomic status (Statistics Canada, 2020c). Low wage workers and individuals with lower educational attainment have faced high rates of unemployment and salary loss during the pandemic (Statistics Canada, 2020c). In addition, individuals living in lower income and marginalized neighbourhoods have had substantially higher rates of COVID-19 infection, likely driven by work in higher-risk occupational settings and reduced capacity for physical distancing (Ontario Agency for Health Protection and Promotion, 2020). Further research is required to better understand if increased visits in this group signal worsening alcohol harms.

The rate of ED visits due to alcohol did not decrease in rural Ontario despite substantial decreases in overall all-cause ED visits. In contrast, ED visits due to alcohol in urban settings declined significantly, resulting in widening geographic-based disparities. A major contributor to this trend was smaller reductions in visits related to acute alcohol use in rural compared to urban settings. The drivers behind the cause of this growing urban-rural disparity are unclear. Available data suggest that during our study time frame, changes in employment during COVID-19 have been comparable between urban and rural Ontario, while the burden of COVID-19 infection was much lower in rural Ontario (Rural Ontario Institute, 2020; Public Health Ontario, 2021). During COVID-19, access to primary care between urban and rural Ontario was similar, suggesting that geographic disparities were not related to differences in health access and reflect underlying stressors (Glazier et al., 2021). Pre-COVID-19, urban and rural Ontario had distinct drinking cultures and patterns of alcohol use with surveys finding that harmful alcohol use was more common in rural regions (Public Health Ontario, 2018). More studies are needed to explore these geographic disparities, however in the interim, investment in better preventive measures and health system interventions related to alcohol use in rural regions may be required.

5. Limitations

Strengths of our study include capturing all ED visits for a population of over 12 million individuals. However, our study has several limitations. First, ED visits due to alcohol are highly specific for alcohol-related harms, but do not capture many alcohol-related conditions and underestimate the overall burden of alcohol on the health of populations and health systems. Second, COVID-19 has resulted in substantial decreases in health service use, including visits related to alcohol, limiting our ability to determine the extent to which alcohol related harms have changed during COVID-19. Finally, our study is primarily descriptive and was designed to identify population-level differences between demographic groups. Critically, the interpretation of results from these study designs are susceptible to ecological fallacy and limited our ability to identify individual-level trends and risk factors for alcohol related harms. Future studies should examine individual-level exposures, such as alcohol use among those with co-morbid mental health and substance use disorders, which have been strongly associated with changes in alcohol use in survey-based studies during the pandemic (Canadian Centre on Substance Abuse and Addiction, 2020).

6. Conclusions

We report results on the extent to which health service use related to

alcohol harms has changed during the first 6 months of COVID-19. While the absolute number of ED visits due to alcohol decreased during COVID-19, the relative burden of alcohol on the health system increased. Specific subpopulations such as rural, lower income, and middle-aged individuals have seen widening disparities in rates of ED visits due to alcohol harms. While further research is needed to better capture how alcohol-related harms have changed during COVID-19, our study suggests that increased alcohol control policies and health system interventions may be required, particularly in higher risk groups.

Author contributions

Daniel T. Myran: Conceptualization, Writing, Data Acquisition, Methodology, Analysis, Visualization, Supervision. **Nathan Cantor:** Writing, Data Acquisition, Methodology, Analysis, Visualization. **Tavis Hayes:** Visualization, Writing – Reviewing and Editing. **Michael Pugliese:** Methodology and Analysis. **Robert Talarico:** Methodology and Analysis. **Paul Kurdyak:** Writing – Reviewing and Editing. **Danial Qureshi** – Data Acquisition. **Peter Tanuseputro:** Writing – Reviewing and Editing, Supervision.

Declaration of Competing Interest

The authors report no declarations of interest.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.drugalcdep.2021.108877>.

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