



The Association Between Alcohol Access and Alcohol#attributable Emergency Department Visits in Ontario, Canada

Citation

Myran, Daniel, Jarvis Chen, Norman Giesbrecht, and Vaughan Rees. 2019. The Association Between Alcohol Access and Alcohol#attributable Emergency Department Visits in Ontario, Canada. *Addiction* 14, no. 7: 1183-1191.

Permanent link

<http://nrs.harvard.edu/urn-3:HUL.InstRepos:42661234>

Terms of Use

This article was downloaded from Harvard University's DASH repository, and is made available under the terms and conditions applicable to Open Access Policy Articles, as set forth at <http://nrs.harvard.edu/urn-3:HUL.InstRepos:dash.current.terms-of-use#OAP>

Share Your Story

The Harvard community has made this article openly available.
Please share how this access benefits you. [Submit a story](#).

[Accessibility](#)

Increasing emergency visits entirely due to alcohol following alcohol sales deregulation in Ontario

OR

Deregulation of alcohol retail sales is associated with increased alcohol-attributable emergency department visits

Daniel T. Myran^{1,2}, Jarvis Chen,³ Norman Giesbrecht³, and Vaughan W. Rees³

1. Department of Epidemiology
Harvard T.H. Chan School of Public Health
Boston, MA 02115
2. Department of Public Health and Preventive Medicine
University of Ottawa, Faculty of Medicine
Ottawa, ON K1H 8M5
3. Department of Social & Behavioral Sciences
Harvard T.H. Chan School of Public Health
Boston, MA 02115
4. Institute for Mental Health Policy Research
Center for Addiction and Mental Health
Toronto, ON M6J 1H4

Corresponding Author:

Dr. Daniel Myran
Harvard T.H. Chan School of Public Health
677 Huntington Ave
Boston, MA 02115
dmyran@hsph.harvard.edu

ABSTRACT

Background. The availability of alcohol through retail outlets is associated with social harms, but few studies have demonstrated a causal relationship with health harms. We used a natural experiment design to examine the impact of the 2015 partial deregulation of alcohol sales in Ontario on emergency department (ED) visits that were entirely attributable to alcohol. We also examined the association between alcohol availability and ED visits

Methods and Findings. A retrospective time series analyses was used to examine rates of ED visits entirely due to alcohol for two time periods: pre-deregulation (2013-2015) and post-deregulation (2016-2017), across 513 defined geographic areas in Ontario. Age-adjusted standardized incidence ratios for each area were calculated using indirect standardization. We compiled a list of all alcohol retail outlets in Ontario during 2014 and 2017 and matched them to their corresponding area. We fit mixed-effects Poisson regression models to: (a) assess the association between number of outlets and hours of operation and ED visits in each area; and (b) assess the impact of deregulation on ED visits using a difference-in-difference analysis.

Alcohol-attributed ED visits increased 17.8% over the study period; over twice the rate of increase for all ED visits. ED visits in women increased 4% more rapidly than men. Socially and economically marginalized areas had higher rates of ED visits due to alcohol. Increased hours of operation and number of alcohol outlets within an area were positively associated with increased rates of ED visits due to alcohol. ED visits due to alcohol increased by 7% (IRR 1.07; 95% CI 1.05-1.09) in areas that introduced alcohol sales in grocery stores following deregulation.

Conclusions. Alcohol availability and socio-economic marginalization were significantly associated with ED visits entirely attributable to alcohol. Deregulation resulted in an estimated additional 3359 alcohol-attributed ED visits over a two-year time period. These harms likely

represent a fraction of the overall impact of the policy change. Policies to ameliorate alcohol-related harms and social inequities should include placing limits on the number of alcohol outlets and hours of operation, particularly in marginalized areas.

ABBREVIATIONS

Emergency Department (ED)

Canadian Institute of Health Information (CIHI)

The Liquor Control Board of Ontario (LCBO)

Forward Sortation Area (FSA)

Alcohol and Gaming Commission of Ontario (AGCO)

Ontario Marginalization Index (OMI).

INTRODUCTION

Alcohol consumption results in a large burden on human health and has been increasing worldwide as a cause of preventable disease, moving from sixth in 1990 to third in 2010.(1) In Canada alcohol is the second leading cause of preventable death and disability.(2) In 2015, 22.7 million Canadians (77% of those over age 15) reported consuming alcohol in the past year. Among those who drank alcohol, 4.3 million (20%) and 3.3 million (15%) reporting drinking enough to be at risk of chronic and immediate harms from alcohol respectively.(3) Recent attention has highlighted the burden of alcohol on the health system: between 2015 and 2016 there were over 77 000 hospitalizations entirely attributable to alcohol in Canada; more than the number of admissions for coronary artery disease.(4) Consistent with research describing the “alcohol paradox” individuals of lower socioeconomic status, who on average consume less alcohol, had disproportionately higher levels of admissions.(4)(5)

In the past two decades there has been a trend towards increased privatization and deregulation of alcohol sales in Canada.(6–8) In 2015, the government of Ontario became the latest province to deregulate sales, by allowing grocery stores to apply for a license to sell wine, beer and cider .(9) This policy will add 450 alcohol outlets by 2020, resulting in a 28.8% increase in the number of outlets from 2014. Previous evidence has linked increased physical accessibility of alcohol to various harms, including violent crime, alcohol-related motor vehicle crashes, child and spousal abuse, rates of suicide, and rates of binge and underage drinking.(10)(11)(12) However, the association between alcohol availability and health risks are less well established.(13) In addition, prior research on the association between alcohol availability and alcohol-related harm is has not been able to ascertain causality: that is, whether

increasing alcohol access promotes consumption resulting in greater harms, or whether pre-existing demand for alcohol supports better access in regions already at risk of alcohol harm.(14)

The 2015 deregulation presents an opportunity for a natural experiment to better explore this relationship. We used data from the Canadian Institute of Health Information (CIHI) to examine emergency department (ED) visits that are considered 100% attributable to alcohol in the province of Ontario. We considered ED visits entirely due to alcohol a sentinel indicator of overall alcohol harms. There were four objectives of this research: 1) to explore temporal trends in ED visits due to alcohol in Ontario, 2) to examine the association between marginalization and ED visits entirely due to alcohol, 3) examine the association between alcohol availability and ED visits entirely due to alcohol, 4) examine the impact of the 2015 policy change on ED visits and hospitalizations entirely due to alcohol. The findings of this study have direct policy implications for Ontario and other regions considering deregulating alcohol sales or increasing access to alcohol sales.

METHODS

Setting. Ontario is the largest province in Canada with a population of 13.48 million people in 2016.(15) The retail sale of alcohol in Ontario is regulated by the provincial government and occurs through a mix of 5 different chains of stores. The largest retailer is The Liquor Control Board of Ontario (LCBO) which is owned and operated by the provincial government and sells spirits, wine and beer. The LCBO also licenses “agency stores” operated out of convenience stores or small grocery stores in rural communities. The second largest retailer is a private company called “The Beer Store” that sells beer. Two additional retailers, “The Wine Rack”, and the “Wine Shop” are privately owned and operated and sell wine. Since 2015, selected privately owned grocery stores have sold beer, wine and cider. Ontario wineries and breweries are also

able to sell alcohol for consumption off site, due to the low volume of sales we excluded these retailers from analyses.

Study Design. A retrospective time series analysis using ambulatory data was used to analyze ED visits entirely due to alcohol for all individuals older than 10 years of age living in Ontario for the years 2012/2013, 2013/2014, 2015/2016, and 2016/2017. We examined at the association between ED visits entirely due to alcohol and the availability of alcohol across 513 geographic area. We used a difference in differences approach to examine the impact of the 2015 policy change on ED visits entirely due to alcohol.

Primary Outcome. We used the ICD-10 codes from the CIHI indicator “Hospitalizations Entirely Caused by Alcohol” to define ED visits entirely caused by alcohol, see appendix A for complete list of ICD-10 codes. (16) All ED visits in Ontario were compiled using visits recorded in the National Ambulatory Care Reporting System Metadata (NACRS).

The aggregate level cross tabulated data set was provided by CIHI including numbers of ED visits for men and women in four age categories (10-24, 25-44, 45-64, 65+) for the 513 FSAs in Ontario for the fiscal years 2012-2013-2013-2014 (“pre” policy) intervention and 2015-2016-2016-2017 (“post” policy). Data suppression for the ED visits was 1.56% due to small cell counts. We used the population for the 2016 census data as the at-risk population for the fiscal years 2015-2016 and 2016-2017 when calculating rates. We used linear interpolation between the 2011 census and 2016 census to calculate the population for 2013 which was used as the at-risk population for 2012-2013 and 2013-2014.

Alcohol Outlets

In October 2017, we accessed the websites of the LCBO, Beer Store, Wine Rack, Wine Shop and Government of Ontario to compile list of off-premise alcohol retail outlets. A complete

list of all alcohol outlets (N= 1792) was extracted from these websites and cross referenced with a list of alcohol outlets provided by Alcohol and Gaming Commission of Ontario (AGCO) under a freedom of information request. The hours of operation in October 2017 for all individual alcohol outlets was extracted using information from official store websites. We used the WayBack machine, an internet archive resource, to access the historical websites of the retailers and compile a list of alcohol outlets for 2014.

There is no consensus in the literature on how to measure alcohol access.(12) We chose to use the *total number of alcohol outlets* in an FSA and the *average store hours* within an FSA, controlling for both total population and total land area (km²).

Neighborhood Characteristics

We used the Forward Sortation Area (FSA) as the geographic unit in this study. FSAs are identified by the first 3 digits of the 6 digits of the postal code of a person's residence and are the smallest geographic unit that CIHI releases patient data for. The mean population for an FSA in Ontario in the 2016 census was 26, 215 (SD = 18, 629). Neighborhood marginalization was characterized using a validated marginalization index for the province of Ontario, called the Ontario Marginalization Index (OMI).(17) The OMI measures four dimensions; residential instability, material deprivation, dependency, and ethnic concentration. Residential instability measures family or housing instability. Material deprivation measures the inability for communities to purchase essential material needs. Dependency measures individuals without income from employment. Ethnic concentration measures concentrations of both recent migrants and visible minorities. The FSA marginalization was calculated by taking the population weighted average of Dissemination Area scores (the smallest reported census unit) within each

FSA. We included each dimension of the OMI separately in the models as the dimensions varied in the direction and strength of correlated with the outcome (ED visits attributable to alcohol).

Data Analysis. All Data Analysis was conducted in STATA Version 15.1. We used mixed effects Poisson models with random intercepts to examine the association between alcohol availability and alcohol-attributable ED visits and the impact of the 2015 policy change on ED visits. We used indirect standardization to compute expected counts for each FSA using rates for all of Ontario applied to FSA specific population counts. All Poisson models were offset by the age adjusted expected number of ED visits providing us with an incident rate ratio.

RESULTS

Emergency Department visits entirely attributable to alcohol. There was a total of 303,733 ED visits entirely due to alcohol in Ontario over the four fiscal years 2012-2014 and 2015-2017. A total of 12.1% of all ED visits in Ontario were for conditions entirely due to alcohol. There was a crude 17.8% increase in the number of ED visits entirely due to alcohol between the pre and post policy time. In comparison the total number of ED visits in Ontario increased by 7.87%. See Table 1.

Table 1. Changes in the total number of overall hospitalizations and ED visits in Ontario and the Hospitalizations and ED visits entirely due to alcohol between 2012-2014 and 2015-2017.

	Total Ontario ED Visits(18)	Number of ED Visits Entirely due to Alcohol
2012-2014 (“Pre Policy”)	11,644,829	134,853
2015-2017 (“Post Policy”)	12,560,822	158,878
Percent Increase in Visits	7.87%	17.82%
Total	24,205,651	293,731

ED visits in men increased over time and peaked in the 45-64 age range. Conversely, women showed a peak of ED visits in the 10-24 age group with decreasing rates of visits with age (see Figure 1).

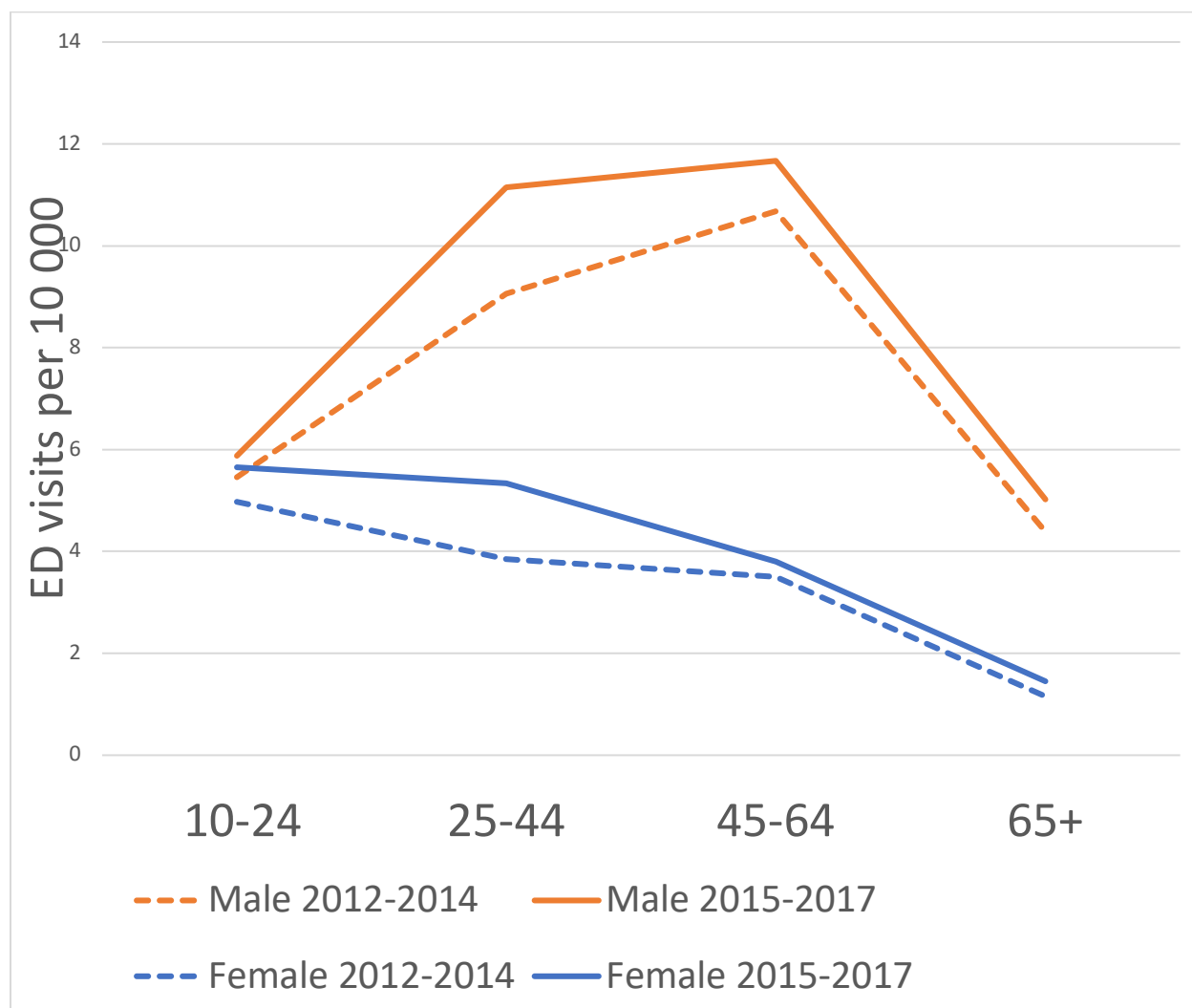


Figure 1. Line graph depicting rates of ED visits entirely due to alcohol per 10 000 population in Ontario for men and women over two time periods.

Causes of ED Visits. In Table 2 we list the causes of ED visits. The majority (88.96%) were for “Mental and behavioural disorders due to use of alcohol”.

Table 2. Proportion of ED visits entirely due to alcohol by ICD-10-CA codes*

Type of ED visit	ICD-10-CA	Total Number	Percent
Mental and Behavioural disorders due to use of alcohol	F10	278548	88.96
Alcohol liver disease	K700	11034	3.52
Alcohol Induced Pancreatitis (acute / chronic)	K852, K860	3598	1.15
Toxic effect of alcohol	T51, G312	7741	2.47
Accidental or intentional self-poisoning by and exposure to alcohol	X45, X65, Y15	7427	2.37
Alcoholic Gastritis	K292	3904	1.25
Mental disorders and diseases of the nervous system complicating pregnancy, childbirth and the puerperium	Q34, Q99	60	0.02
Other	E244, G621, G721, I426, Q86, R780	799	0.26

*The sum for Table 2 is not the same as values for Table 1 as individuals could receive multiple ICD-10-CA diagnoses at the time of discharge from the ED.

Association Between Alcohol Availability, Marginalization and ED visits

There were a total of 15 Alcohol Outlets in Ontario in 2014. This number increased by 15.1% to 1792 by October 2017 including the addition of 208 grocery stores that began selling alcohol. These 208 grocery stores were located in 159 unique FSAs containing 5.413 million individuals or 45.1% of the population of Ontario 10 years or older. The number of alcohol outlets within a FSA ranged from 0 to 31. Grocery stores selling alcohol in Ontario were open on average 14 hours more per week than the government run LCBO stores.

We fit mixed effects Poisson models of the log of the standardized incident ratio to examine the association between alcohol availability, gender, marginalization, and the number of ED visits for each FSA. The marginalization of a FSA was significantly associated with ED visits. Each quintile increase in residential instability and material deprivation was associated with an increase in ED visits of 25% and 19% respectively. Each quintile increase in ethnic

marginalization was associated with 14% fewer ED visits. ED visits increased by 16% in men and 20% in women between the pre and post time period. In the fully adjusted model we found that each additional alcohol outlet in a FSA was associated with a 2.4% increase in the number of ED visits, see Table 3. Model A, presents the association between the total number of outlets in an FSA adjusted for gender, population density (in deciles), the pre and post policy time period and an interaction between gender and time period. Model B presents the association between the ED visits and the marginalization of the FSA. Model C, presents a fully adjusted model for the association between the number of alcohol outlets, marginalization, and ED visits entirely attributable to alcohol.

Table 3. Mixed effects Poisson regression modeling the association between observed number of ED visits attributable to alcohol, marginalization, and alcohol access, offset by the age adjusted expected number of ED visits.

	Model A IRR (95%CI)	Model B IRR (95%CI)	Model C IRR (95%CI)
Number of Alcohol Outlets	1.024 (1.02-1.03)*		1.024 (1.02-1.03)*
Female	0.47 (0.47-0.48)*	0.47 (0.47-0.48)*	0.47 (0.47-0.48)*
Post Policy Time	1.16 (1.14-1.17)*	1.17 (1.16-1.18)*	1.16 (1.14-1.17)*
Female * Post Policy Time	1.04 (1.03-1.06)*	1.04 (1.03-1.06)*	1.04 (1.03-1.06)*
Population Density (Decile)	1.05 (1.03-1.08)*	1.03 (1.00-1.07)**	1.04 (1.01-1.08)**
OMI (Quintiles)			
Dependency		0.97 (0.92-1.01)	0.96 (0.92-1.01)
Instability		1.25 (1.19-1.31)*	1.25 (1.19-1.31)*
Deprivation		1.19 (1.14-1.25)*	1.19 (1.14-1.24)*
Ethnicity		0.86 (0.80-0.92)*	0.86 (0.81-0.93)*

* Indicates $P < 0.0001$

** Indicates $P < 0.05$

We fit the variables included in the final model from Table 3 with the average weekly hours of operation for alcohol outlets within a FSA. Each 10-hour increase in the average

number of hours that outlets were open in a FSA was associated with a corresponding 2% increase in ED visits. This effect remained after adjusting for the total number of outlets within a FSA, see Table 4. Model A, presents the association between the average hours of operation for outlets in an FSA. Model B adds the total number of alcohol outlets per FSA.

Table 4. Mixed effects Poisson regression modeling the association between observed number of ED visits and average alcohol store hours of operation offset by the age adjusted expected number of ED visits.

	Model A IRR (95% CI)	Model B IRR (95% CI)
Measures of Access		
Average Store Hours (10-hour increments)	1.02 (1.01-1.02)*	1.014 (1.01-1.02)*
Number of Alcohol Outlets		1.022 (1.02-1.03)*
Female	0.47 (0.47-0.48)*	0.47 (0.47-0.48)*
Post Policy Time	1.16 (1.15-1.18)*	1.15 (1.14-1.16)*
Female * Post Policy Time	1.04 (1.03-1.06)*	1.04 (1.03-1.06)*
Population Density (Decile)	1.03 (1.00-1.07)	1.04 (1.01-1.07)**
OMI (Quintile)		
Dependency	0.96 (0.92-1.01)	0.96 (0.92-1.00)
Instability	1.24 (1.19-1.30)*	1.25 (1.19-1.31)*
Deprivation	1.19 (1.14-1.25)*	1.19 (1.14-1.24)*
Ethnicity	0.86 (0.80-0.92)*	0.86 (0.81-0.92)*

* Indicates $P < 0.0001$

** Indicates $P < 0.05$

2015 Policy Change. In Table 5 we present a comparison of the number of ED visits in FSAs for the time period before the 2015 policy change and the time period following the policy change. Our main effect compared FSAs that did or did not have a newly operating grocery store selling alcohol in the post period. We adjusted for baseline differences between the two groups and offset our regression using the age standardized expected number of ED visits. Model A shows the impact on ED visits for regions that had a grocery store begin selling alcohol. Model B shows

the fully adjusted relationship accounting for population density, marginalization and an interaction between gender and time.

There was a trend in the baseline rate of ED visits between FSAs that opened a grocery store after the 2015 policy change and FSAs that did not open a grocery store after the policy change. After adjusting for population density and marginalization scores this trend became significant with a 15% higher baseline rate of ED visits in FSAs that opened a grocery store compared to those that did not. Following the policy change FSAs that added a grocery store had an additional 6.6% more ED visits than FSAs that did not. We found no evidence of a dose response for increasing numbers of grocery stores selling alcohol within a FSA.

Table 5. Two mixed effects Poisson regression for total number of ED visits entirely due to alcohol and the presence of grocery stores selling alcohol in a neighborhood.

	Model A IRR (95% CI)	Model B IRR (95% CI)
Policy Group [^]	1.08 (0.93-1.26)	1.15 (1.03-1.29)**
Post Policy Time	1.16 (1.15-1.17)*	1.14 (1.13-1.16)*
Policy Group * Post Policy Time	1.07 (1.05-1.09)*	1.07 (1.05-1.09)*
Female	0.48 (0.48-0.49)*	0.47 (0.47-0.48)*
Female*Post Policy Time		1.04 (1.03-1.06)*
Population Density (Decile)		1.04 (1.00-1.07)**
OMI (Quintile)		
Dependency		0.97 (0.93-1.02)
Instability		1.24 (1.19-1.30)*
Deprivation		1.19 (1.14-1.25)*
Ethnicity		0.85 (0.79-0.91)*

[^] Policy group is a binary variable. FSAs that contained a grocery store that began selling alcohol post 2015 are scored as 1 and FSAs that did not contain a grocery store selling alcohol post 2015 are scored as 0.

* Indicates $P < 0.0001$

** Indicates $P < 0.05$

DISCUSSION

Using data from the province of Ontario we examined the association between alcohol availability, marginalization, and the impact of the 2015 deregulation of alcohol sales on ED visits entirely due to alcohol. Following the 2015 deregulation of alcohol sales, the number of outlets within Ontario increased by 15.1%. Both the number of alcohol outlets within an FSA and the average store hours were positively associated with greater ED visits due to alcohol. Overall, the number of ED visits entirely due to alcohol increased faster between 2012 and 2017 than overall trends in ED visits in Ontario. Women had half the risk of ED visits due to alcohol; however, rates of ED visits in women increased faster than in men between the two time periods. Finally, the number of ER visits due to alcohol in FSAs that had a grocery store selling alcohol following the policy change was 6.4% higher than predicted.

Our findings are consistent with evidence from the US that has demonstrated a pattern of increasing ED visits due to alcohol, as well as disproportionate increases amongst women.(19) We found that among men rates of ED visits increased with age, while among women the rate of ED visits was highest in the youngest (ages 10-24) age range. As alcohol harms are generally expected to increase with age, this finding was unexpected. Evidence suggests that rates of binge drinking are increasing in women—particular young women—both in Canada and globally. (20) (21) If younger women are indeed engaging in more risky drinking, this cohort of women may continue to face increasing harms from alcohol as they age.

We found that neighborhoods with increased levels of material deprivation and residential instability had higher rates of ED visits entirely due to alcohol. FSAs in the most marginalized quintiles of residential instability and material deprivation had 228% and 240% more ED visits, respectively, compared to the least marginalized quintile. These findings are consistent with evidence suggesting that both individuals and regions of lower SES have higher

rates of alcohol related harms.(22) (23) Conversely, areas with higher numbers of visible minorities and migrants had 46% fewer ED visits entirely due to alcohol. These results may be explained by research examining drinking patterns among migrants to Canada, which found that, on average, individuals born outside of Canada consume less alcohol than Canadian born individuals.(24) In addition, some individuals living in regions of high ethnic concentration may be protected by the healthy immigrant effect (HIE), where immigrants to a country are on average healthier than the native born population.(25)

We found a significant association between two measures of alcohol availability, average weekly hours of operation for individual stores and total number of stores, and ED visits for conditions entirely due to alcohol. In the fully adjusted model (Table 4. Model B) FSAs in the quintile with the highest number of alcohol outlets had 24.1% more ED visits due to alcohol than FSAs in the quintile with the lowest number of alcohol outlets. The highest quintile of average hours of operation had 13.1% more ED visits due to alcohol than the lowest quintile.

Conceptually, physical availability of alcohol outlets is thought to mediate price, exposure to alcohol marketing, and social norms around drinking and binge drinking. (26) Previous work in British Columbia found an associated 3.25% increase in alcohol related deaths for each quintile increase in private alcohol outlet density.(27) Similarly, work in Scotland has found that increasing alcohol outlet density is associated with more hospitalizations due to alcohol.(28) Our finding adds further to this literature by showing that both increased hours of operation for alcohol outlets and physical availability independently contribute to alcohol related harms.

After adjusting for relevant variables, we found that regions with grocery store that began selling alcohol after 2015 had an additional 7% more ED visits than predicted by the overall temporal trend. In addition, after adjusting for marginalization we found that FSAs that opened a

grocery store selling alcohol had higher rates of ED visits due to alcohol even before the policy change came into effect. Our findings provide evidence supporting both that increased alcohol availability results in increased health harms due to alcohol and that alcohol outlets may be more likely to open in areas where alcohol-related demand and consequent harms are higher.

Deregulation in Ontario appears to have accelerated harms in regions already at higher risk of ED visits due to alcohol.

In addition to having extended hours of sales of alcohol and increased physical access to outlets, deregulation of the alcohol market has likely caused increased ED visits through several mechanisms. First, deregulation has increased the proportion of outlets that are privately owned and operated. Prior evidence has found that privatization of alcohol outlets results in increased per capita alcohol sales. In addition, private outlets may be more likely to sell alcohol to minors and less likely to comply with age verifications.(29) (30) Deregulation may have also increased exposure to alcohol marketing and promotion through point of sale promotion at grocery stores. Studies have found that alcohol advertising influences drinking norms, and intentions to drink especially among young adults.(31)

Estimated Harms. There were 47,983 ED visits in the 159 FSAs that would open grocery stores for the two fiscal years 2012/2013 and 2013/2014. We therefore estimate that the 2015 policy change has resulted in an additional 3359 ED visits ($47,983 * 0.07$) entirely due to alcohol in Ontario for 2015-2017. ED visits entirely due to alcohol represent only a small portion of health and societal harms due to alcohol. In data from England hospitalizations entirely due to alcohol represent just 22.3% of hospitalizations in which alcohol was a contributing factor.(32) Using this ratio we estimate that the policy change has contributed to an additional 15,062 ED visits over the two years.

Limitations. There were several limitations to this study. First, the geographic unit of analysis, the FSA, is primarily designed for the purpose of postal delivery, and can comprise large geographic regions and substantial population heterogeneities. Aggregating marginalization and population over FSAs may introduce residual confounding by socioeconomic variables.(33) Second, our spatial measures of alcohol availability, number of alcohol outlets per FSA is a crude measure of access. More sophisticated measures of alcohol availability such as travel time to the nearest alcohol outlet would represent a “gold standard” measure of access. Finally, as our data include only a pre and post time period we are unable to draw conclusions about long term trends in ED visits entirely due to alcohol in Ontario. Future research using longitudinal data, and individual level data, including home address to allow for calculation of more sophisticated measures of alcohol access, would increase confidence in these findings.

Conclusions. Our findings raise concerns that alcohol deregulation has resulted in increased health harms in the province of Ontario and has accelerated a pre-existing trend towards increasing alcohol harms. ED visits entirely due to alcohol represent the tip of the iceberg of the health and societal impacts of alcohol consumption, deregulation has likely had negative societal and health impact far beyond the immediately observed ED visits. Other jurisdictions considering alcohol deregulation should take caution from these findings.

The present data highlight the need for ongoing regulations to protect the population from alcohol harm. Our findings support recent research showing that evidence-based policy interventions to reduce alcohol accessibility continue to be needed. Continued efforts to implement increased taxation on alcohol and minimum unit pricing, further regulation of alcohol marketing, increasing emphasis on screening brief intervention referral and treatment by primary

care providers, limits on weekly hours of operation, and limits on the location of alcohol outlets particularly in marginalized regions must be pursued.(34) (35)

DECLARATIONS

Parts of this material are based on data and information provided by the Canadian Institute for Health Information. However, the analyses, conclusions, opinions and statements expressed herein are those of the authors, and not necessarily those of the Canadian Institute for Health Information.

ACKNOWLEDGEMENTS

We thank Suan Mowers and Rene Duplain, data librarians at the University of Ottawa, for their assistance accessing data from the Canadian census. Ben Bearnot and John Pearson helped retrieve the hours of operation for the grocery stores in Ontario.

ETHICS APPROVAL

Given that this study uses de-identified aggregate level data it was deemed exempt from institutional review board approval (Harvard IRB, IRB17-1981).

FUNDING STATEMENT

Funding for the open access fee for publication of this work was provided by Harvard University under the HOPE fund. <https://osc.hul.harvard.edu/programs/hope/>

The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.”

COMPETING INTERESTS

All authors declare no competing interests.

CONTRIBUTIONS

Contributors: DM conceived the study and is the lead author, corresponding author, and guarantor. DM, JC, NG, and VR, contributed to study design, data interpretation, and manuscript revisions. DM and JC contributed to data analysis. DM searched the literature. DM, JC, and VR, all contributed to the first draft of the manuscript. DM had full access to all the data in the study and had final responsibility for the decision on content and publication submission. All authors have seen and approved the final text.

References

1. Lim SS, Vos T, Flaxman AD, Danaei G, Shibuya K, Adair-Rohani H, et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* [Internet]. 2012 Dec 15 [cited 2018 Feb 7];380(9859):2224–

60. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/23245609>
2. Canadian Public Health Association Position Paper A Public Health Approach to Alcohol Policy in Canada. 2011 [cited 2018 Feb 7]; Available from: https://www.cpha.ca/sites/default/files/assets/positions/position-paper-alcohol_e.pdf
3. Canadian Tobacco Alcohol and Drugs (CTADS): 2015 summary - Canada.ca [Internet]. [cited 2018 Feb 12]. Available from: <https://www.canada.ca/en/health-canada/services/canadian-tobacco-alcohol-drugs-survey/2015-summary.html>
4. Alcohol Harm in Canada Examining Hospitalizations Entirely Caused by Alcohol and Strategies to Reduce Alcohol Harm. [cited 2017 Oct 3]; Available from: <https://www.cihi.ca/sites/default/files/document/report-alcohol-hospitalizations-en-web.pdf>
5. Jones L, Bates G, McCoy E, Bellis MA. Relationship between alcohol-attributable disease and socioeconomic status, and the role of alcohol consumption in this relationship: a systematic review and meta-analysis. *BMC Public Health* [Internet]. 2015 Dec 18 [cited 2018 May 1];15(1):400. Available from: <http://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-015-1720-7>
6. Trollid B. An investigation of the effect of privatization of retail sales of alcohol on consumption and traffic accidents in Alberta, Canada. *Addiction* [Internet]. 2005 May [cited 2018 May 21];100(5):662–71. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/15847624>
7. Stockwell T, Zhao J, Marzell M, Gruenewald PJ, Macdonald S, Ponicki WR, et al. Relationships Between Minimum Alcohol Pricing and Crime During the Partial Privatization of a Canadian Government Alcohol Monopoly. *J Stud Alcohol Drugs* [Internet]. 2015 Jul [cited 2018 May 21];76(4):628–34. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/26098040>
8. Stockwell T, Zhao J, Giesbrecht N, Macdonald S, Thomas G, Wettlaufer A. The Raising of Minimum Alcohol Prices in Saskatchewan, Canada: Impacts on Consumption and Implications for Public Health. *Am J Public Health* [Internet]. 2012 Dec [cited 2018 May 21];102(12):e103–10. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/23078488>
9. Initial Report: The Premier’s Advisory Council on Government Assets | Ontario.ca [Internet]. [cited 2018 May 14]. Available from: <https://www.ontario.ca/page/initial-report-premiers-advisory-council-government-assets#section-3>
10. Popova S, Giesbrecht N, Bekmuradov D, Patra J. Hours and Days of Sale and Density of Alcohol Outlets: Impacts on Alcohol Consumption and Damage: A Systematic Review. *Alcohol Alcohol* [Internet]. 2009 Sep 1 [cited 2017 Nov 28];44(5):500–16. Available from: <https://academic.oup.com/alcalc/article-lookup/doi/10.1093/alcalc/agg054>
11. Campbell CA, Hahn RA, Elder R, Brewer R, Chattopadhyay S, Fielding J, et al. The Effectiveness of Limiting Alcohol Outlet Density As a Means of Reducing Excessive Alcohol Consumption and Alcohol-Related Harms. *Am J Prev Med* [Internet]. 2009 Dec [cited 2017 Nov 28];37(6):556–69. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/19944925>
12. Holmes J, Guo Y, Maheswaran R, Nicholls J, Meier PS, Brennan A. The impact of spatial and temporal availability of alcohol on its consumption and related harms: a critical review in the context of UK licensing policies. *Drug Alcohol Rev* [Internet]. 2014 Sep [cited 2017 Nov 28];33(5):515–25. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/25186193>

13. Campbell CA, Hahn RA, Elder R, Brewer R, Chattopadhyay S, Fielding J, et al. The Effectiveness of Limiting Alcohol Outlet Density As a Means of Reducing Excessive Alcohol Consumption and Alcohol-Related Harms. *Am J Prev Med* [Internet]. 2009 Dec 1 [cited 2018 May 21];37(6):556–69. Available from: <http://linkinghub.elsevier.com/retrieve/pii/S0749379709006047>
14. LIVINGSTON M. Alcohol outlet density and harm: Comparing the impacts on violence and chronic harms. *Drug Alcohol Rev* [Internet]. 2011 Sep 1 [cited 2017 Nov 28];30(5):515–23. Available from: <http://doi.wiley.com/10.1111/j.1465-3362.2010.00251.x>
15. Census Profile, 2016 Census - Ontario [Province] and Canada [Country] [Internet]. [cited 2018 Feb 9]. Available from: <http://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=PR&Code1=35&Geo2=PR&Code2=01&Data=Count&SearchText=ontario&SearchType=Begins&SearchPR=01&B1=All&TABID=1>
16. Alcohol Harm in Canada | CIHI [Internet]. [cited 2018 May 11]. Available from: <https://www.cihi.ca/en/alcohol-harm-in-canada>
17. Matheson, FI; Ontario Agency for Health Protection and Promotion (Public Health Ontario). 2011 Ontario marginalization index. Toronto, ON: St. Michael's Hospital; 2017. Joint publication with Public Health Ontario. [Internet]. [cited 2018 Feb 6]. Available from: <http://www.torontohealthprofiles.ca/ont/onmargON.php>
18. (CIHI) CI for HI. Trends in Acute Inpatient Hospitalizations and Emergency Department Visits. [cited 2018 May 17]; Available from: <https://secure.cihi.ca/estore/productSeries.htm?pc=PCC526>
19. White AM, Slater ME, Ng G, Hingson R, Breslow R. Trends in Alcohol-Related Emergency Department Visits in the United States: Results from the Nationwide Emergency Department Sample, 2006 to 2014. *Alcohol Clin Exp Res* [Internet]. 2018 Feb 1 [cited 2018 May 18];42(2):352–9. Available from: <http://doi.wiley.com/10.1111/acer.13559>
20. Cheng HG, Anthony JC. A new era for drinking? Epidemiological evidence on adolescent male–female differences in drinking incidence in the United States and Europe. *Soc Psychiatry Psychiatr Epidemiol* [Internet]. 2017 Jan 3 [cited 2018 May 19];52(1):117–26. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/27915406>
21. Bulloch AGM, Williams JVA, Lavorato DH, Patten SB. Trends in binge drinking in Canada from 1996 to 2013: a repeated cross-sectional analysis. *C open* [Internet]. 2016 Oct 13 [cited 2018 Jun 3];4(4):E599–604. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/28018872>
22. Jones L, Bates G, McCoy E, Bellis MA. Relationship between alcohol-attributable disease and socioeconomic status, and the role of alcohol consumption in this relationship: a systematic review and meta-analysis. *BMC Public Health* [Internet]. 2015 Apr 18 [cited 2018 Jun 1];15:400. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/25928558>
23. Probst C, Roerecke M, Behrendt S, Rehm J. Socioeconomic differences in alcohol-attributable mortality compared with all-cause mortality: a systematic review and meta-analysis. *Int J Epidemiol* [Internet]. 2014 Aug [cited 2018 Jun 1];43(4):1314–27. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/24618188>
24. Agic B, Mann RE, Tuck A, Ialomiteanu A, Bondy S, Simich L, et al. Alcohol use among immigrants in Ontario, Canada. *Drug Alcohol Rev* [Internet]. 2016 Mar [cited 2018 Jun 1];35(2):196–205. Available from: <http://doi.wiley.com/10.1111/dar.12250>

25. Moher D, Liberati A, Tetzlaff J, Altman D, Group TP. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Med*. 2009;6(6):e1000097.
26. Campbell CA, Hahn RA, Elder R, Brewer R, Chattopadhyay S, Fielding J, et al. The Effectiveness of Limiting Alcohol Outlet Density As a Means of Reducing Excessive Alcohol Consumption and Alcohol-Related Harms. *Am J Prev Med* [Internet]. 2009 Dec [cited 2018 Feb 7];37(6):556–69. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/19944925>
27. Stockwell T, Zhao J, Macdonald S, Vallance K, Gruenewald P, Ponicki W, et al. Impact on alcohol-related mortality of a rapid rise in the density of private liquor outlets in British Columbia: a local area multi-level analysis. *Addiction* [Internet]. 2011 Apr [cited 2018 Apr 7];106(4):768–76. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/21244541>
28. Richardson EA, Hill SE, Mitchell R, Pearce J, Shortt NK. Is local alcohol outlet density related to alcohol-related morbidity and mortality in Scottish cities? *Health Place* [Internet]. 2015 [cited 2017 Nov 27];33:172–80. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4415114/pdf/main.pdf>
29. Giesbrecht N, Bosma LM. 1. Preventing Alcohol-Related Problems. In: *Preventing Alcohol-Related Problems: Evidence and Community-Based Initiatives* [Internet]. American Public Health Association; 2017 [cited 2018 Jun 25]. Available from: <http://ajph.aphapublications.org/doi/10.2105/9780875532929ch01>
30. Hahn RA, Middleton JC, Elder R, Brewer R, Fielding J, Naimi TS, et al. Effects of Alcohol Retail Privatization on Excessive Alcohol Consumption and Related Harms. *Am J Prev Med* [Internet]. 2012 Apr [cited 2018 Jun 25];42(4):418–27. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/22424256>
31. Public Health Ontario. Focus On: Alcohol Marketing. 2016 [cited 2017 Nov 13]; Available from: https://www.publichealthontario.ca/en/eRepository/Focus_On_Alcohol_Marketing.pdf
32. Public Health England. Local Alcohol Profiles for England [Internet]. [cited 2018 Jun 15]. Available from: <https://fingertips.phe.org.uk/profile/local-alcohol-profiles/data#page/3/gid/1938132984/pat/6/par/E12000004/ati/102/are/E06000015/iid/91414/age/1/sex/4>
33. Finkelstein MM. Ecologic Proxies for Household Income: How Well Do They Work for the Analysis of Health and Health Care Utilization? [Internet]. Vol. 95, *Canadian Journal of Public Health / Revue Canadienne de Santé Publique*. Canadian Public Health Association; [cited 2018 May 14]. p. 90–4. Available from: <http://www.jstor.org/stable/41994105>
34. Babor TF, McRee BG, Kassebaum PA, Grimaldi PL, Ahmed K, Bray J. Screening, Brief Intervention, and Referral to Treatment (SBIRT). *Subst Abus* [Internet]. 2007 Nov 21 [cited 2018 Jun 3];28(3):7–30. Available from: http://www.tandfonline.com/doi/abs/10.1300/J465v28n03_03
35. Burton R, Henn C, Lavoie D, O'Connor R, Perkins C, Sweeney K, et al. A rapid evidence review of the effectiveness and cost-effectiveness of alcohol control policies: an English perspective. *Lancet* (London, England) [Internet]. 2017 Apr 15 [cited 2018 Apr 7];389(10078):1558–80. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/27919442>

Appendix

Table 1. ICD-10-CA codes for diagnoses included in the CIHI indicator “Hospitalizations entirely due to alcohol”

Description	ICD-10-CA codes
Alcohol-induced pseudo-Cushing’s syndrome	E24.4
Mental and behavioural disorders due to use of alcohol	F10
Degeneration of nervous system due to alcohol	G31.2
Alcoholic polyneuropathy	G82.1
Alcoholic myopathy	G72.1
Alcoholic cardiomyopathy	I42.6
Alcoholic gastritis	K29.2
Alcoholic liver disease	K70
Alcohol-induced acute pancreatitis	K85.2
Alcohol-induced chronic pancreatitis	K86.0
Maternal care for (suspected) damage to fetus from alcohol	O35.4
Mental disorders and diseases of the nervous system complicating pregnancy, childbirth and the puerperium	O99.3 (only if F10 is coded in the same abstract as type (3))
Fetal alcohol syndrome (dysmorphic)	Q86.0
Finding of alcohol in blood	R78.0
Toxic effects of alcohol	T51
Accidental poisoning by and exposure to alcohol	X45
Intentional self-poisoning by and exposure to alcohol	X85
Poisoning by and exposure to alcohol, undetermined intent	Y15

