



## Short communication

## The distribution of alcohol-attributable healthcare encounters across the population of alcohol users in Ontario, Canada

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## ARTICLE INFO

## Keywords:

Alcohol use  
Universal policies  
Prevention paradox  
Substance use  
Geoffrey Rose  
Canada

## ABSTRACT

Recent evidence suggests there may be no safe level of alcohol use as even low levels are associated with increased risk for harm. However, the magnitude of the population-level health burden from lower levels of alcohol use is poorly understood. The objective was to estimate the distribution of alcohol-attributable healthcare encounters (emergency department (ED) visits and hospitalizations) across the population of alcohol users aged 15+ in Ontario, Canada. Using the International Model of Alcohol Harms and Policies (InterMAHP) tool, wholly and partially alcohol-attributable healthcare encounters were estimated across alcohol users: (1) former (no past-year use); (2) low volume ( $\leq 67.3$  g ethanol/week); (3) medium volume ( $>67.3$ – $134.5$  g ethanol/week for women and  $>67.3$ – $201.8$  g ethanol/week for men); and (4) high volume ( $>134.5$  g ethanol/week for women and  $>201.8$  g ethanol/week for men). The alcohol-attributable healthcare burden was distributed across the population of alcohol users. A small population of high volume users (23% of men, 13% of women) were estimated to have contributed to the greatest proportion of alcohol-attributable healthcare encounters, particularly among men (men: 65% of ED visits and 71% of hospitalizations, women: 49% of ED visits and 50% of hospitalizations). The 71% of women low and medium volumes users were estimated to have contributed to a substantial proportion of alcohol-attributable healthcare encounters (47% of ED visits and 34% of hospitalizations). Findings provide support for universal alcohol policies (i.e., delivered to the entire population) for reducing population-level alcohol-attributable harm in addition to targeted policies for high-risk users.

## 1. Introduction

Alcohol is a leading cause of death and disability globally (Shield et al., 2020), and is associated with >200 negative health conditions including communicable and non-communicable diseases, and injuries (Shield et al., 2020). Evidence from the Global Burden of Disease study suggests the safest level of alcohol use is zero as even low levels are associated with increased risk for harm (Griswold et al., 2018). However, the magnitude of the population-level health burden from lower levels of alcohol use remains poorly understood. Geoffrey Rose's

“prevention paradox” is helpful for explaining the distribution of alcohol-attributable harm, highlighting that when a risk factor is diffuse across the population, disease cases accrue in populations with low or moderate disease risk (e.g., lower volume users) because they are more numerous than those with higher risk (e.g., high volume users) (Rose, 1985; McLaren et al., 2010). It is important to understand “who” experiences alcohol-attributable harm and at “what” level of alcohol use to inform policy in Canada and internationally.

Previous literature from around the world has observed low and medium risk alcohol users contribute significantly to the population-

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<https://doi.org/10.1016/j.pmedr.2023.102388>

Received 8 May 2023; Received in revised form 15 August 2023; Accepted 24 August 2023

Available online 25 August 2023

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level alcohol-attributable health burden (Rossow and Romelsjö, 2006; Caetano et al., 2012; Antai et al., 2014; O'Dwyer et al., 2019; Sherk et al., 2020; Meier et al., 2021; Thomas, 2012). However, most studies failed to capture the wide breadth of alcohol-attributable harm, including where alcohol plays a partial role such as injuries and cancers. Moreover, studies have largely relied on participants' self-report of limited health and social harms (e.g., alcohol use causing family problems) (Caetano et al., 2012; Antai et al., 2014; O'Dwyer et al., 2019; Thomas, 2012), and few studies used administrative health records to directly estimate alcohol-attributable harm (Rossow and Romelsjö, 2006; Sherk et al., 2020; Meier et al., 2021). A 2020 study from the Canadian province of British Columbia estimated hospitalizations and deaths that were partially and wholly attributable to alcohol across users dichotomized as "low" or "high risk" using Canada's 2011 Low-Risk Drinking Guidelines (LRDG) (defined as  $\leq 201.8$  g ethanol/week for men and  $\leq 134.5$  g ethanol/week for women) (Sherk et al., 2020). People using alcohol within Canada's 2011 LRDG were not insulated from a wide range of alcohol-attributable hospitalizations and deaths, and the dichotomization of alcohol use prevents a more comprehensive understanding of the distribution of alcohol-attributable harm across levels of use, particularly at lower levels (Thomas, 2012). The current study aims to estimate the distribution of a wide range of wholly and partially alcohol-attributable healthcare encounters, including emergency department (ED) visits and hospitalizations, across former, low, medium, and high volume alcohol users in Ontario, Canada.

## 2. Methods

Wholly and partially alcohol-attributable healthcare encounters across alcohol users aged 15+ in Ontario's universal healthcare system were estimated by sex/gender. The International Model of Alcohol Harms and Policies (InterMAHP) tool (Sherk et al., 2020), a health condition-based alcohol-attributable fraction approach, was used to estimate alcohol-attributable healthcare encounters in Ontario from population-based health administrative data, including all alcohol-attributable ED visits in 2019 (from the National Ambulatory Care Reporting System) and hospitalizations in 2018 (the most recently available data from the Canadian Institute for Health Information's Discharge Abstract Database and the Ontario Mental Health Reporting System).

Using InterMAHP, we estimated population-level alcohol use as a continuous distribution of average daily alcohol use from data on Ontario alcohol sales and population-based prevalence estimates of alcohol use derived from the Canadian Substance Use Exposure Database. Four alcohol user groups were defined to reflect the wide range of alcohol use in a population and the large variation in international LRDG: (Kalinowski and Humphreys, 2016) (1) former (no past-year use); (2) low volume ( $\leq 67.3$  g ethanol/week); (3) medium volume ( $>67.3$ – $134.5$  g ethanol/week for women and  $>67.3$ – $201.8$  g ethanol/week for men); and (4) high volume ( $>134.5$  g ethanol/week for women and  $>201.8$  g ethanol/week for men). Alcohol user groups were defined using Canadian standard drinks, shown in Appendix A (1 Canadian standard drink = 13.45 g ethanol). Then, the number of wholly and partially alcohol-attributable healthcare encounters was estimated among each user group by sex/gender. Wholly alcohol-attributable healthcare encounters were enumerated from health administrative data and included those where alcohol use was necessary to cause the condition and would not occur otherwise (e.g., alcohol poisoning, alcohol-induced pancreatitis). Partially attributable healthcare encounters (e.g., cancer, unintentional injuries) were estimated using condition-based alcohol-attributable fractions automated by InterMAHP. For each alcohol-attributable condition, relative risk functions summarizing the relationship between population-level alcohol use and the risk of the condition were applied to obtain alcohol-attributable fractions which were multiplied by the number of healthcare encounters for the condition to produce counts for each alcohol user group by

sex/gender (Sherk et al., 2020). This methodological approach is consistent with international studies including the Global Burden of Disease study (Griswold et al., 2018). Available in Appendix B is a detailed description of InterMAHP methodology and a list of wholly and partially alcohol-attributable conditions considered by InterMAHP based on prior research on the global burden causally related to alcohol use (Sherk et al., 2020).

Biological sex (female/male) and gender (women/men) are often used interchangeably in the data sources integrated by InterMAHP. We interpret our findings with the understanding that alcohol use and attributable healthcare encounters are influenced by both sex-based physiological differences and gender-related social and cultural factors, which are inseparably linked. As such, we use the terms sex/gender, women and men. This study received ethics clearance from Public Health Ontario's Research Ethics Board (File number: 2020003.01).

## 3. Results

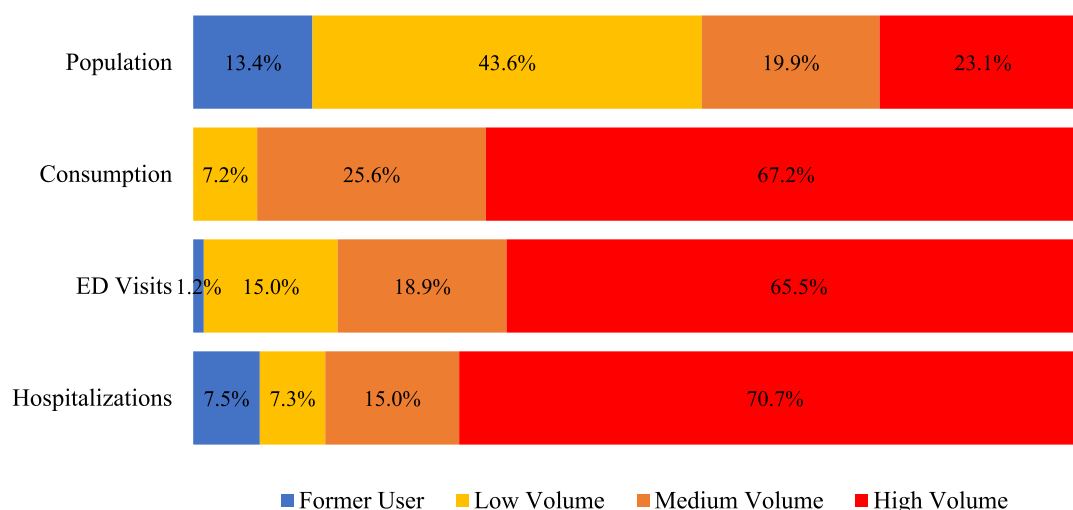
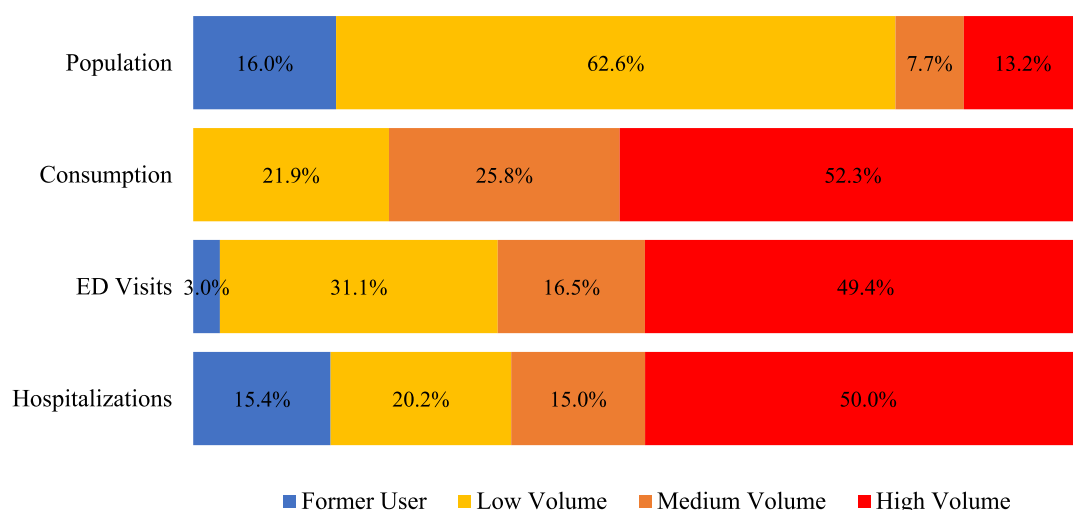
We estimated 231,914 alcohol-attributable ED visits in 2019 and 34,158 alcohol-attributable hospitalizations in 2018 in Ontario. A greater proportion of all alcohol-attributable healthcare counters was estimated among men (ED visits: 68.7%, hospitalizations: 70.7%).

Total alcohol consumed and alcohol-attributable healthcare encounters were estimated across alcohol user groups by sex/gender (Fig. 1). We estimated 72.2% of women and 79.5% of men used alcohol in the past 12 months (i.e., current users) in 2018/19. Among current and former users, most were estimated to be low volume alcohol users, which was 20% greater among women (62.6%) than men (43.6%). The proportion of high volume users was greater among men (23.1%) than women (13.2%), despite the threshold for high volume in this study being 67.25 g ethanol/week (i.e., 5 Canadian standard drinks/week) greater for men.

High volume alcohol users were estimated to have a large disproportionate contribution to alcohol-attributable healthcare encounters. The 23.1% of men high volume users consumed 67.2% of total alcohol and contributed to 65.5% and 70.7% of alcohol-attributable ED visits and hospitalizations, respectively (Fig. 1A). Compared to men, the 13.2% of women high volume users accounted for a substantial but lower proportion of total alcohol (52.3%) and alcohol-attributable healthcare encounters (49.4% of ED visits, 50.0% of hospitalizations) (Fig. 1B).

Over a third of women low and medium volume users (70.3%) consumed 47.7% of total alcohol and contributed to 47.6% and 35.2% of alcohol-attributable ED visits and hospitalizations, respectively. Women low volume users alone (62.6%) contributed to a substantial proportion of all alcohol-attributable healthcare encounters (31.1% of ED visits, 20.2% of hospitalizations). Men low volume users (43.6%) consumed 7.2% of total alcohol and contributed to 15.0% and 7.3% of alcohol-attributable ED visits and hospitalizations, respectively.

Partially alcohol-attributable healthcare encounter estimates were further disaggregated across alcohol user groups (Table 1). Among men, 73.9% and 68.8% of alcohol-attributable ED visits and hospitalizations were from partially alcohol-attributable conditions, respectively (73.4% and 68.8% among women, respectively). Most partially alcohol-attributable healthcare encounters (53.9% of ED visits, 60.5% of hospitalizations) were estimated among men high volume alcohol users. However, among women, partially alcohol-attributable healthcare encounters were distributed across the alcohol user population. For example, women low volume, high volume, and former alcohol users contributed to 27.1%, 31.9%, and 22.4% of partially alcohol-attributable hospitalizations, respectively. Most wholly alcohol-attributable healthcare encounters ( $>90\%$ ) were estimated among men and women high volume alcohol users.

**a) Men****b) Women**

**Fig. 1.** (a and b) The proportion of total alcohol consumed and alcohol-attributable healthcare encounters (emergency department (ED) visits in 2019 and hospitalizations in 2018) in Ontario estimated across alcohol user groups (former, low, medium, and high volume) for (a) men ( $n = 6,025,343$ ) and (b) women ( $n = 6,248,839$ ). Former alcohol users had no past-year alcohol use; low volume alcohol users had an average of up to 67.3 g ethanol/week, medium volume users had >67.3–134.5 g ethanol/week for women and >67.3–201.8 g ethanol/week for men, high volume users had >134.5 and >201.8 g ethanol/week for women and men, respectively.

#### 4. Discussion

Findings from Ontario, Canada's most populous province, suggest the alcohol-attributable healthcare burden is not limited to high volume alcohol users but rather, the burden is distributed across the population of alcohol users with differences by sex/gender. A disproportionately large amount of alcohol-attributable healthcare encounters was estimated among the relatively small population of high volume alcohol users which was especially evident among men. Yet, a substantial amount of alcohol-attributable healthcare encounters was estimated among the relatively large population of low and medium volumes users, in line with Rose's prevention paradox (Rose, 1985; McLaren et al., 2010). This large healthcare burden was especially apparent among women low and medium volume users, as women are more susceptible to harm sooner and at lower levels of alcohol use than men (Erol and Karpyak, 2015). The majority of alcohol-attributable healthcare encounters were estimated to be from partially alcohol-attributable

conditions, which were distributed across the entire population of women alcohol users. In the Canadian context, our findings reinforce Canada's 2023 updated Guidance on Alcohol and Health which lowered weekly low-risk limits compared to the previous 2011 LRDG and may particularly benefit women who experience greater alcohol-attributable harm at lower volumes of alcohol compared to men. Our findings substantiate the need for alcohol policies that reduce harm among all alcohol users including those using low and medium volumes which may be viewed by the public as "safe" (Paradis et al., 2023).

Our findings from Ontario are consistent with other Canadian (Sherk et al., 2020) and international studies mostly from high-income countries, including Norway, Sweden (Rossow and Romelsjö, 2006), Brazil (Caetano et al., 2012), the U.S. (Antai et al., 2014), Ireland (O'Dwyer et al., 2019), and the U.K. (Meier et al., 2021), demonstrating that the small number of high risk alcohol users experience the greatest amount of alcohol-attributable harm overall, but substantial harm is also experienced by the larger number of lower risk alcohol users. Previous

**Table 1**

The proportion (%) of partially alcohol-attributable healthcare encounters (emergency department visits in 2019 and hospitalizations in 2018) estimated across alcohol user groups (former, low, medium, and high volume alcohol users) for men and women.

| Partially Alcohol-Attributable Emergency Department Visits |             |            |               |             |           |
|------------------------------------------------------------|-------------|------------|---------------|-------------|-----------|
|                                                            | Former User | Low Volume | Medium Volume | High Volume | Total (N) |
| Men                                                        | 1.6%        | 19.3%      | 25.1%         | 53.9%       | 117,804   |
| Women                                                      | 4.1%        | 41.7%      | 21.9%         | 32.3%       | 53,311    |

| Partially Alcohol-Attributable Hospitalizations |             |            |               |             |           |
|-------------------------------------------------|-------------|------------|---------------|-------------|-----------|
|                                                 | Former User | Low Volume | Medium Volume | High Volume | Total (N) |
| Men                                             | 10.8%       | 9.8%       | 18.8%         | 60.5%       | 16,598    |
| Women                                           | 22.4%       | 27.1%      | 18.6%         | 31.9%       | 6,900     |

Former alcohol users had no past-year alcohol use; low volume alcohol users had an average of up to 67.3 g ethanol/week, medium volume users had >67.3–134.5 g ethanol/week for women and >67.3–201.8 g ethanol/week for men, high volume users had >134.5 and >201.8 g ethanol/week for women and men, respectively.

studies that estimated alcohol-attributable harm using alcohol-attributable fractions accounted for potential protective effects of alcohol in analyses (Sherk et al., 2020; Meier et al., 2021), which are now being forcefully contested as recent global research shows there is no safe level of alcohol use and no protective net effect for lifetime risk of morbidity and mortality (Griswold et al., 2018). The methods of these previous studies accounted for potentially “prevented” alcohol-attributable healthcare encounters by subtracting them from the estimated number of alcohol-attributable healthcare encounters to produce a net estimate. As a consequence, the potential protective effects of alcohol, which are estimated mostly at lower volumes of use and among women, conceals population-level harm and distorts understandings of the health risks at all volumes of alcohol use (Stockwell et al., 2007). Our analysis considered conditions with non-protective alcohol-attributable fractions only to estimate the burden of healthcare encounters.

It is difficult to compare the distribution of alcohol-attributable harm across studies internationally as alcohol user groups are often categorized based on country-specific LRDG (Caetano et al., 2012; Sherk et al., 2020; Meier et al., 2021). Daily LRDG limits across countries can differ by a factor of almost six (Kalinowski and Humphreys, 2016), resulting in important differences in alcohol use within volume-based groups. Furthermore, differences in findings from international studies may exist compared to Ontario due to differences in factors beyond alcohol use affecting population-level alcohol-attributable harm including differences in alcohol regulatory policies (e.g., taxation, availability), access to health care and alcohol treatment programs, and societal acceptance of alcohol use.

The widespread distribution of alcohol-attributable harm across alcohol users has important policy implications. Findings support universal alcohol policies that aim to reduce alcohol use per capita (APC). Reducing alcohol use among both lower and higher volume users, as opposed to only targeted policies directed to high-risk users, is a foundational concept of Rose’s population strategy of prevention approach (Rose, 1985; McLaren et al., 2010). APC strongly predicts alcohol-attributable harm in a population, and universal alcohol policies work by effectively reducing APC by what Rose describes as “shifting” the whole distribution of consumption (Rossow and Mäkelä, 2021). When APC is reduced, so is alcohol use at low, medium, and high volumes, and this is the mechanism that reduces the proportion of heavy drinkers in a population (Rossow and Mäkelä, 2021). Universal alcohol policies include controls on alcohol availability, price, and advertising, and are well established as the most cost-effective policies to reduce alcohol use across the entire user population and minimize alcohol-attributable

harm (Babor et al., 2022). Despite similar recommendations made by Giesbrecht and colleagues in 2011 for a comprehensive two-tiered policy response of both universal and targeted policies to reduce harm from alcohol in Canada (Giesbrecht et al., 2011), little progress has been made as governments in Ontario and other jurisdictions have been weakening long-standing universal alcohol policies (Babor et al., 2022). Skeptics of universal alcohol policies, including the alcohol industry, often argue for “drinking responsibly” and are less likely to resist harm reduction policies directed at high-risk alcohol users to reduce instances of intoxication (Babor et al., 2022). While policies targeting a small number of high-risk alcohol users may reduce individual-level risk, they are unlikely to reduce population-level alcohol-attributable harm across all alcohol users and the proportion of heavy drinkers in a population (Rossow and Mäkelä, 2021).

Growing international literature also suggests universal alcohol policies can have heterogeneous impacts across socio-demographic subpopulations, including by sex/gender (Meier et al., 2021; Blas and Sivasankara Kurup, 2010). A modelling study in England found the introduction of a 10% tax increase and minimum unit prices were more effective at reducing alcohol use and harm among men, as women were more likely to maintain their consumption and increase spending following the price policy (Meier et al., 2021). Given our findings that women low volume alcohol users accounted for a greater proportion of all alcohol-attributable healthcare encounters than men low volume users and the growing evidence base that rates of alcohol-attributable harm have been increasing among women in recent years (Erol and Karpyak, 2015; Smith et al., 2023), understanding potential heterogeneous responses to universal alcohol policies is an important area for future research and can ensure prevention efforts reach all relevant equity-seeking subpopulations.

Strengths of this study include the use of InterMAHP methodology that integrates relative risks from high-quality meta-analyses and automates the calculation of alcohol-attributable fractions to estimate alcohol harm across users. Detailed data on alcohol use and sales were used to estimate alcohol user groups that reflect the wide range of alcohol use in a population. Additionally, both wholly and partially alcohol-attributable harm were directly estimated from administrative health records capturing all ED visits and hospitalizations in Ontario. Limitations of InterMAHP have been described in detail elsewhere (Sherk et al., 2020; Smith et al., 2023), including the use of relative risks from different countries and time periods which can reflect alcohol-attributable mortality when morbidity risks were not available. It was not possible to disaggregate former users into those with no lifetime alcohol use and those who stopped using in the past year for health-related reasons; this should be a consideration for future research with different data sources and methodologies as it may impact the estimation of alcohol-attributable healthcare encounters. Additionally, these findings may only be relevant to Ontario and regions in other high-income countries. The burden of disease from alcohol in low- and middle-income countries is significant and alcohol use patterns may differ (Shield et al., 2020; Safiri et al., 2019). To inform broader international policy, future research should critically evaluate the distribution of alcohol-attributable healthcare encounters across alcohol users in low- and middle-income countries and lend comparisons to Canada and other high-income countries.

## 5. Conclusion

A substantial proportion of alcohol-attributable harm in Ontario occurs among people using lower volumes of alcohol, especially among women. Given this alcohol use and harm profile, universal alcohol policies should be defended and promoted, in combination with targeted high-risk policies, to equitably reduce population-level alcohol-attributable harm in Ontario and other regions across Canada and internationally.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Data availability

The authors do not have permission to share data.

## Acknowledgements

The authors gratefully acknowledge the contributions of Nicole Schoer for conducting the manuscript's initial analyses.

## Funding source

This research was funded by the Canadian Institute of Health Research (Project Grant #PJT-173552).

## Appendix A and B

Appendix A and B to this article can be found online at <https://doi.org/10.1016/j.pmedr.2023.102388>.

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