

Rates of emergency department visits attributable to alcohol use in Ontario from 2003 to 2016: a retrospective population-level study

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ABSTRACT

BACKGROUND: Alcohol use causes a large burden on the health of Canadians, and alcohol-related harms appear to be increasing in many high-income countries. We sought to analyze changes in emergency department visits attributable to alcohol use, by sex, age and neighbourhood income over time.

METHODS: All individuals aged 10 to 105 years living in Ontario, Canada, between 2003 and 2016 were included in this study. The primary outcome was age-standardized rates of emergency department visits attributable to alcohol use, defined using diagnostic codes from the Canadian Institute for Health Information Health Indicator “hospitalizations entirely caused by alcohol.” We compared rates of these

visits using a retrospective population-level design.

RESULTS: Among 15 121 639 individuals, there were 765 346 emergency department visits attributable to alcohol use over the study period. Between 2003 and 2016, the age-standardized rates of these visits increased more in women (86.5%) than in men (53.2%), and the increase in rates of emergency department visits attributable to alcohol use was 4.4 times greater than the increases in the rates of overall emergency department visits. Individuals aged 25–29 years experienced the largest change in the rate of emergency department visits attributable to alcohol use (175%). We found evidence of age-cohort effects, whereby the rate of emergency department visits attributable to alcohol use at

age 19 years increased on average by 4.07% (95% confidence interval [CI] 3.71%–4.44%) per year for each cohort born between 1986 and 1999. Individuals in the lowest neighbourhood income quintile had 2.37 (95% CI 2.27–2.49) times the rate of emergency department visits attributable to alcohol use than those in the highest income quintile. This disparity increased slightly over the study period.

INTERPRETATION: Although men and lower-income individuals have the highest burden of emergency department visits attributable to alcohol use, the largest increases in visits have been in women and younger adults. Further research should focus on potential causes of these trends to provide guidance on how to reduce alcohol-related harms.

In Canada, alcohol use led to an estimated 5.8% of deaths in men and 0.6% of deaths in women in 2017.¹ Alcohol use also imposes a substantial burden on the Canadian health system; between 2014 and 2015, there were 77 000 hospital admissions entirely attributable to alcohol, exceeding the number of admissions for coronary artery disease.² A growing body of evidence from the United States, England and Australia has found that alcohol-related mortality and harms, such as hospital admissions or emergency department visits attributable to alcohol use, have increased over the past 2 decades.^{3–5} In 2015, rates of hospital admissions attributable to alcohol in Canada were higher in

men than in women and older adults.² Furthermore, mortality rates specifically attributable to alcohol-related liver disease have been increasing over time in Canada.¹ However, data are lacking on how population-level emergency department visits or hospital admissions attributable to alcohol use in Canada have changed over time and, importantly, whether any changes differ by factors such as age, sex and socioeconomic status.

Although alcohol harms appear to be increasing in high-income countries, to our knowledge, only one study set in England has examined contemporary population-level changes in alcohol-related harms by age, sex and income.⁴ Emerging data

from the US examining the phenomenon known as the “deaths of despair” (i.e., death by drug poisoning, suicide and alcoholic liver disease) have shown widening socioeconomic gradients, with disproportionate increases in these deaths among white non-Hispanic individuals with lower income and educational attainment.⁶ Although Canadian data have also shown disparities in alcohol-related harms between low- and high-income groups,⁷ data are lacking on changes in this relation over time.

There are important differences between Canada and the US, including less pronounced income inequality, different population demographics, distinctive patterns of alcohol consumption by socioeconomic groups and, in general, more stringent controls on alcohol in Canada.⁸ Consequently, although US-based studies are informative, a better understanding of Canadian-specific trends contributing to alcohol-related harms is pertinent to identifying high-risk populations, and for guiding public health policy and patient care.

To address these gaps, we examined temporal patterns of change in emergency department visits attributable to alcohol use, by sex, age and neighbourhood income, between 2003 and 2016 in Ontario, the largest province in Canada.

Methods

Study design and population

We conducted a retrospective population-level study in Ontario, Canada, using administrative data collected from the province's universal health care system. We included all individuals over the age of 10 years — for whom harmful alcohol use could be considered as intentional — between Jan. 1, 2003, and Dec. 31, 2016. We excluded individuals not eligible for the provincial health insurance program and those older than 105 years.

Data sources

Data sets used in this study included the National Ambulatory Care Reporting System database, which contains visit records from emergency departments; the Registered Persons Database, a registry of all individuals eligible for the provincial health insurance plan containing individual demographic information such as age, sex and postal code of primary residence; and the 2011 Postal Code Conversion File Plus, which contained information on individuals' neighbourhood income quintile and the rurality of their home address. These data sets were linked using unique, encoded identifiers assigned to each person and analyzed at ICES. The population-level database used in this study has been estimated to capture 100% of emergency department visits in Ontario.⁹

Outcomes

The primary outcome was an emergency department visit attributable to alcohol use, defined using a set of diagnostic codes from the *International Classification of Diseases, 10th Revision* (ICD-10) contained in the Canadian Institute for Health Information Health Indicator “hospitalizations entirely caused by alcohol.” Emergency department visits were considered to be attributable to alcohol use when a code from the indicator was listed

as the main reason for the visit or having contributed to the visit (see Appendix 1, Supplementary Table 1, available at www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.181575/-/DC1, for the complete list of codes). In addition, we examined changes in emergency department visits, attributable to any cause, in Ontario over the same period.

Statistical analysis

We calculated frequencies, proportions and standardized differences to characterize and compare the study population across age groups, sex and neighbourhood income quintiles. Rates were directly standardized by age (when appropriate) using the 2011 Census population as the reference (the most recent available reference year at the time of analysis). As the study was conducted at the population level (using a census of the population instead of randomly selected samples from within a population), inferential statistical analyses were not performed to compare absolute changes between 2003 and 2016.¹⁰ We calculated risk ratios (RRs) to compare rates of emergency department visits in low-income and high-income neighbourhoods, and the average annual percent change to compare rates of visits across birth cohorts. We then conducted time-trend analyses on changes in the ratio between high- and low-income neighbourhoods and between rates of visits in different birth cohorts using Poisson models with year as a continuous predictor and population size as an offset. All analyses were performed using SAS software version 9.4.3.

Ethics approval

ICES is a prescribed entity under section 45 of Ontario's *Personal Health Information Protection Act*. Section 45 authorizes ICES to collect personal health information, without consent, for the purpose of analysis or compiling statistical information with respect to the management of, evaluation or monitoring of, allocation of resources to or planning for all or part of the health system. This project was conducted under section 45, and approved by the ICES Privacy and Compliance Office.

Results

Burden of emergency department visits attributable to alcohol use

Our cohort included 15 121 639 individuals who were followed for an average of 11.05 (4.28) person-years for a total of 167 228 195 person-years. There were 765 346 emergency department visits (32.3% female patients) attributable to alcohol use incurred by 480 611 Ontario residents aged between 10 and 105 years over the 14-year study period. This represented 1.18% of the total number of emergency department visits in Ontario. Women who experienced an emergency department visit attributable to alcohol use were more likely than men to be below the legal drinking age of 19 years (17.4% women, 9.1% men). Women were less likely to be in the lowest income quintile and to have visited the emergency department more than once because of alcohol use in the past year (Table 1). Emergency department visits attributable to alcohol use resulted in a higher rate of subsequent

Table 1: Characteristics of Ontario residents who visited the emergency department because of alcohol use, 2003–2016 (n = 480 611)

Characteristic	No. (%) of patients*		Standardized difference
	Women n = 170 225	Men n = 310 386	
No. of visits attributable to alcohol use (% of total visits), n = 765 346			–
No. of visits in year of initial visit, mean ± SD	1.45 ± 2.05	1.67 ± 3.32	0.80
1 visit	141 481 (83.1)	246 752 (79.5)	0.09
2 visits	15 971 (9.4)	32 940 (10.6)	0.04
3 visits	5234 (3.1)	11 681 (3.8)	0.04
4 visits	2425 (1.4)	5711 (1.8)	0.03
≥ 5 visits	5114 (3.0)	13 302 (4.3)	0.07
Age, yr†			
Age, mean ± SD	36.42 ± 17.79	41.09 ± 17.31	0.27
10–18	29 646 (17.4)	28 315 (9.1)	0.25
19–24	33 312 (19.6)	47 220 (15.2)	0.12
25–40	38 398 (22.6)	74 084 (23.9)	0.03
41–64	56 003 (32.9)	130 635 (42.1)	0.19
65–80	10 799 (6.3)	26 811 (8.6)	0.09
> 80	2067 (1.2)	3321 (1.1)	0.01
Income quintile			
1 (lowest)	48 754 (28.6)	95 616 (30.8)	0.05
2	33 115 (19.5)	63 896 (20.6)	0.03
3	29 115 (17.1)	54 271 (17.5)	0.01
4	28 130 (16.5)	47 917 (15.4)	0.03
5 (highest)	28 867 (17.0)	43 932 (14.2)	0.08
Population centre and rural area classification			
Large urban population centre (≥ 100 000)	110 660 (65.0)	207 245 (66.8)	0.01
Medium population centre (30 000–99 999)	16 170 (9.5)	27 476 (8.9)	0.02
Small population centre (1000–29 999)	18 600 (10.9)	31 815 (10.3)	0.04
Rural population centre (< 1000)	24 731 (14.5)	43 797 (14.1)	0.01

Note: SD = standard deviation.
*Unless stated otherwise.
†The legal drinking age in Ontario is 19 years.

admission to hospital (13.1%) than general emergency department visits (9.6%).

The most common diagnostic codes for emergency department visits attributable to alcohol use were for intoxication (44.6%), harmful use (21.4%), withdrawal (11.4%) and alcohol dependence (10.9%). The most common medical harms were alcoholic liver disease (2.8%), alcoholic gastritis (1.5%) and alcohol poisoning (2.6%) (Table 2). A full list of individual diagnostic codes stratified by sex is available in Appendix 1, Supplementary Table 1. The average annual percentage change in the crude and age- and sex-adjusted rates of codes per 10 000 individuals are available in Appendix 1, Supplementary Table 2. In 2003, alcohol-related ICD codes were listed as the main reason for visiting the emergency department for 66.7% of visits and as a contributing

reason in 33.3% of visits. In 2016, 71.7% of codes were listed as the main reason for visiting the emergency department.

Temporal trends in emergency department visits attributable to alcohol use

The total number of emergency department visits attributable to alcohol, the number of individuals visiting the emergency department because of alcohol use, and the average number of emergency department visits attributable to alcohol use per individual increased between 2003 and 2016 (Table 3). With stratification by sex, the absolute increase in age-standardized incidence of emergency department visits attributable to alcohol between 2003 and 2016 was greater in men (27.19 per 10 000 individuals v. 17.91 per 10 000 individuals). However, the relative

Table 2: Changes in number of visits to the emergency department attributable to alcohol use by diagnostic codes, 2003–2016

ICD-10 code*	No. of visits			Absolute % increase†
	All years	2003	2016	
Mental health harms				
Acute intoxication (F100)	363 566	18 341	34 276	86.9
Harmful use (F101)	174 942	9376	17 979	91.8
Alcohol dependence (F102)	89 118	6496	6737	3.7
Alcohol withdrawal (F103, F104)	93 332	4282	11 010	178.2
Mental and behavioural disorders due to use of alcohol, other, i.e., psychosis, amnesic syndrome (F105–F109)	8846	380	1313	245.5
Medical harms				
Alcoholic liver disease (K700–K704, K709)	23 192	1063	2,452	130.7
Alcoholic gastritis (K292)	11 799	771	976	26.6
Accidental or intentional poisoning by alcohol (X45, Y15, X65)	21 532	1187	1898	59.9
Other medical conditions due to alcohol, i.e., alcohol induced: acute pancreatitis, neuropathy, cardiomyopathy (G312, G621, G721, I426, K852, K860, E244, T510, T519, R780)	28 618	1753	2775	58.3
Maternal care for (suspected) damage to fetus from alcohol/Fetal alcohol syndrome (Q99304, Q99305, Q860, P043)	878	6	134	2133.3
Total	815 823‡	43 655	79 550	82.2

Note: ICD-10 = *International Classification of Diseases, 10th Revision*.
*See Appendix 1, Supplementary Table 1 (available at www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.181575/-/DC1) for the full description of the ICD-10 codes in the indicator.
†See Appendix 1, Supplementary Table 2 for an analysis of the annual percentage increase in rates of ICD-10 codes accounting for changes in population demographics.
‡Total number of codes exceeds the total number of emergency department visits because some visits were considered to be caused by more than 1 alcohol-related harm and therefore were assigned more than 1 ICD-10 code.

Table 3: Temporal trends in emergency department visits attributable to alcohol use and all-cause emergency department visits, 2003–2016

Characteristic	Women			Men		
	2003	2016	Absolute % increase	2003	2016	Absolute % increase
No. of all-cause visits	2 010 480	2 836 984	41.1*	1 878 141	2 430 534	29.4*
No. of visits attributable to alcohol	11 868	24 951	110.2*	27 962	49 669	77.6*
No. of individuals who visited because of alcohol use	8823	15 408	75.6*	17 167	27 348	59.3*
No. of visits attributable to alcohol per year in individuals with an initial visit, mean (95% CI)	1.35 (1.32–1.37)	1.62 (1.59–1.67)	20.9†	1.63 (1.58–1.66)	1.82 (1.78–1.86)	11.7†
Age-standardized rate of all-cause visits (per 10 000 population)	3599.73	4312.52	19.8	3506.14	3806.97	8.6
Age-standardized rate of visits attributable to alcohol (per 10 000 population)	20.71	38.62	86.5	51.12	78.31	53.2
Proportion of all visits attributable to alcohol	0.59%	0.88%	49.1	1.49%	2.04%	36.9

Note: CI = confidence interval.
* $p < 0.001$ χ^2 test comparing change between 2003 and 2016 for men and for women.
† $p < 0.001$ t test on difference in averages between 2003 and 2016 for men and for women.

changes were greater among women, who had 1.63 times the increase in age-standardized incidence of emergency department visits attributable to alcohol compared with men. The percentage increase in the age-standardized rate of emergency

department visits attributable to alcohol was 6.20 times greater in men and 4.37 times greater in women than the percentage increase in the age-standardized rate of all-cause emergency department visits.

Age and sex patterns of emergency department visits attributable to alcohol use

Men and women showed bimodal distributions of emergency department visits attributable to alcohol use. The highest rates of emergency department visits attributable to alcohol were observed between ages 15 and 24 years in women and between ages 45 and 54 years in men. The largest increase in the rate of visits was in youths and young adults. Among individuals aged 25–29 years, the rate of visits attributable to alcohol increased by 240% (17.30 to 58.74 per 10 000 individuals) in women and 145% (37.48 to 91.72 per 10 000 individuals) in men between 2003 and 2016. In addition, the age with the highest rate of emergency department visits attributable to alcohol increased in both women (from 15–18 yr in 2003 to 19–24 yr in 2016) and men (from 45–49 yr in 2003 to 50–54 yr in 2016) (Figure 1).

Age-cohort effects in emergency department visits attributable to alcohol use

We investigated the presence of age-cohort effects using a time-trend analysis examining changes in rates of emergency department visits at age 18, 19 and 20 years for each subsequent birth year between 1986 and 1999. The average annual percentage increase in the rate of emergency department visits attributable to alcohol for women was 5.23% (95% CI 4.65%–5.82%) at 18 years, 5.83% (95% CI 5.28%–6.38%) at 19 years and 6.40% (95% CI 5.80%–7.00%) at 20 years, and for men was 2.30% (95% CI 1.88%–2.93%) at 18 years, 2.65% (95% CI 2.17%–3.14%) at 19 years and 3.66% (95% CI 3.15%–4.17%) at 20 years. Supplementary Figures 1 and 2 (in Appendix 1) display a summary of these trends. Starting in 2007, female youth below the legal drinking age (aged 10–18 yr) had a higher rate of emergency department visits attributable to alcohol than male youth (aged 10–18 yr) who were under the legal drinking age (Appendix 1, Supplementary Table 3).

Association between income and emergency department visits attributable to alcohol use

Over the 14 years of study, individuals living in neighbourhoods in the lowest income quintile had more than twice the rate of emergency department visits attributable to alcohol than individuals living in neighbourhoods in the highest income quintile. This disparity was greater in men (RR 2.78, 95% CI 2.71–2.86) than in women (RR 1.98, 95% CI 1.93–2.02). We used a time-trend analysis to examine changes in the disparity between rates of emergency department visits attributable to alcohol. Between 2003 and 2016, the average annual increase in the rate ratio in the disparity between the lowest and highest income quintile was 0.66% (95% CI 0.44%–0.89%) in men and 0.62% in women (95% CI 0.31%–0.92%). This trend is shown in Appendix 1, Supplementary Figure 3.

Interpretation

Between 2003 and 2016, the increase in the age- and sex-standardized rate of emergency department visits attributable to alcohol was more than 4 times greater than the increase in the rate of all-cause emergency department visits. Although men had more than twice the age-standardized rates of emergency department visits attributable to alcohol that women had throughout the study period, the gap between the sexes narrowed over time. We observed that men and women exhibited unique, age-related patterns of emergency department visits attributable to alcohol, whereby visits were the highest for middle-aged men but peaked in younger women. However, for both sexes, the largest relative increase in alcohol harms over time was found among individuals aged between 19 and 35 years. Finally, individuals living in low-income neighbourhoods had more than twice the rate of emergency department visits attributable to alcohol than people in high-income neighbourhoods. This disparity increased slightly over the study period.

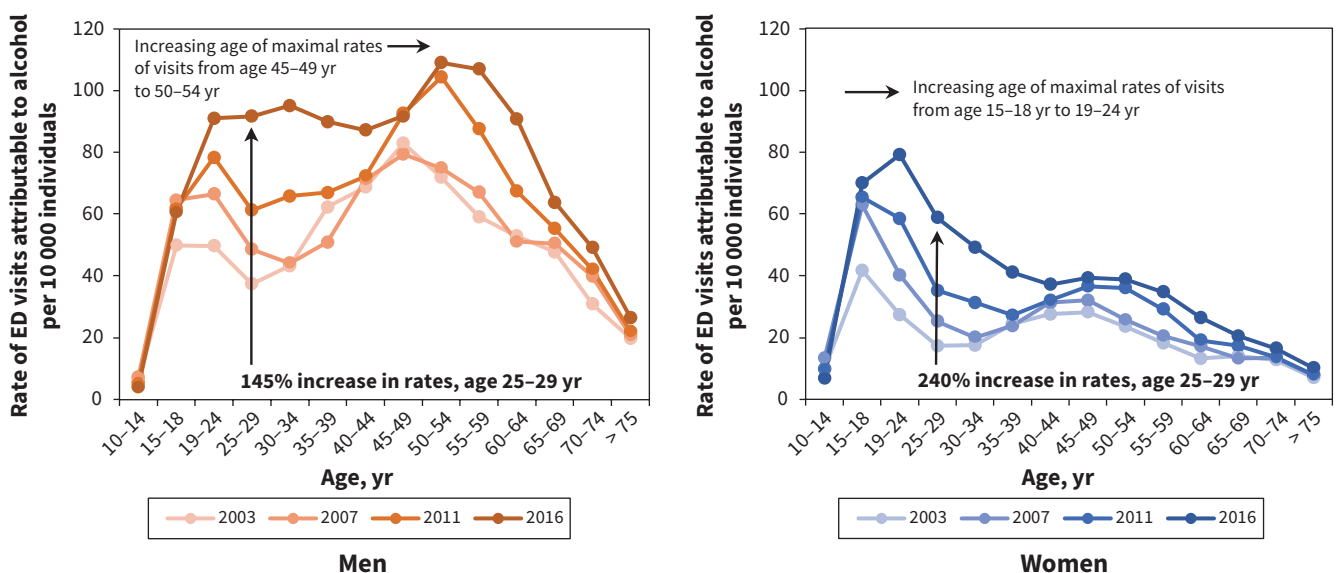


Figure 1: Cross-sectional trends (years 2003, 2007, 2011 and 2016) depicting the unadjusted rates of emergency department (ED) visits attributable to alcohol, in 5-year age increments for men and women.

Our findings of the overall increase in harms attributable to alcohol are consistent with data showing increases in alcohol-related emergency department visits in the US (47.4% between 2006 and 2014), and alcohol-related hospital admissions in British Columbia (44.7%) and England (50.8%) between 2002 and 2014.^{3,4,11} Adding to the literature, our study identified important age, sex and income patterns in Ontario.

First, although men continue to have much higher rates of emergency department visits attributable to alcohol, rates of visits rose faster in women. These observed increases are consistent with data from Ontario and Canada indicating increasing average weekly alcohol consumption and rates of binge drinking over the study time frame, particularly among women.^{12,13} Second, youths and young adults in Ontario experienced the largest increase in emergency department visits attributable to alcohol. These observations signal a possible escalation in harmful patterns of alcohol consumption in younger Ontario residents with potential long-term implications for their health and patterns of health care use later in life. Third, we observed that the population-level increase in emergency department visits attributable to alcohol use is likely driven by the simultaneous rise in the number of individuals visiting the emergency department and by a higher number of repeated visits among these individuals. This finding suggests that there may be an increasing need for services targeting individual with high-risk alcohol consumption within our population. Fourth, consistent with the literature, we found income disparities in emergency department visits attributable to alcohol.^{7,14,15} However, unlike the increases in disparities (i.e., “deaths of despair”) observed in the US, we found that this socio-economic gradient has only modestly increased over time.⁶ Demographic differences, including less heavy drinking among lower-income groups in Canada than in the US, likely contribute to the discrepant trends.⁸ In addition, the alcohol-control environment in Ontario, which includes a minimum price on alcohol, likely reduced riskier patterns of alcohol consumption in lower-income groups.¹⁶ Importantly, although increases in alcohol harms have affected income segments of society equally, further interventions may be required to reduce the initial inequity.

This study was not designed to identify factors contributing to the observed increases in alcohol harms. However, 2 study features may help guide future research. First, our observations suggest that these factors are disproportionately affecting women and younger adults of both sexes. In fact, since 2007, the rates of emergency department visits attributable to alcohol among women have overtaken rates among men for individuals under the legal drinking age. Further research could examine youth-specific risk factors for alcohol harms in Ontario. Second, the alcohol-control environment in Ontario, which includes controls on alcohol price (indexed to inflation) and the availability of alcohol retailers, was stable until the final year of our study.^{17,18} We can therefore infer that factors other than price and availability were likely driving the observed trends.

One possible contributor is increasing alcohol marketing and promotion, which is less tightly regulated in both Ontario and Canada.¹⁹ Recent studies of alcohol marketing in Canada are lacking; however, news reports and commentaries have high-

lighted large increases in marketing directed specifically at women.^{20–22} Future work could explore whether Ontario is experiencing increased alcohol marketing and the potential contribution to the observed rising alcohol-related harms.

Although the alcohol-control environment was stable for most of the study period, it has recently undergone deregulatory changes, including an increase in the availability of alcohol sales (December 2015) and a reduction in the minimum price of alcohol (September 2018).^{18,23} Research, including evidence from Ontario and British Columbia, suggests that such policies may increase alcohol consumption and related harms.^{24,25,26} Further surveillance is needed of trends in alcohol-related harms in Ontario and Canada.

Limitations

Our study has several potential limitations. Our observed changes in emergency department visits attributable to alcohol could be partially explained by changes in diagnostic coding practices by physicians (i.e., the growing awareness of or decreased stigma for alcohol use disorders). However, the gradual increases across several diagnostic codes — including the codes for alcoholic liver disease, which has clear diagnostic criteria and is less likely to experience changes in coding practices — supports the validity of these findings as true increases in the number of events. In addition, the codes used in this study pertain to visits entirely attributable to alcohol, which are highly specific for alcohol-related harms. Although we expanded the literature by identifying population-level differences between demographic groups, our study design is susceptible to ecological fallacy and limited our ability to make causal inferences on individual-level risk factors associated with alcohol harms. Nevertheless, ecological studies are often important for hypothesis generation, and the findings presented here suggest there is a need to further investigate the association between individual-level risk factors (e.g., age, sex, level of education and frequency of use) and the trends in alcohol harms, while accounting for potential within-subject correlation.

Conclusion

Consistent with global trends, health harms and the health system burden of alcohol have increased in Ontario. These harms have disproportionately affected women and young adults. Unlike trends observed in the US, we found only modest increases in the disparity in alcohol-related harm between socioeconomic strata. While further studies should focus on identifying the causes behind increases in these demographic groups, policy-makers should consider increasing interventions to reduce harmful alcohol use, particularly in women and young adults.

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Contributors: Daniel Myran conceived the study, and is the lead author, corresponding author and guarantor. Peter Tanuseputro, Amy Hsu and Glenys Smith contributed to the study design, data interpretation and manuscript revisions. All of the authors contributed to the data analysis. Daniel Myran searched the literature.

All of the authors contributed to drafting the manuscript. Daniel Myran had full access to all the data in the study and had final responsibility for the decision on content and publication submission. All of the authors gave final approval of the version to be published and agreed to be accountable for all aspects of the work.

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Data sharing: The data set from this study is held securely in coded form at ICES. While data sharing agreements prohibit ICES from making the data set publicly available, access may be granted to those who meet pre-specified criteria for confidential access, available at www.ices.on.ca/DAS. The full data set creation plan and underlying analytic code are available from the authors on request, understanding that the computer programs may rely on coding templates or macros that are unique to ICES and are therefore either inaccessible or may require modification.

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