



Burden of Health Conditions Attributable to Smoking and Alcohol by Public Health Unit in Ontario

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About Ontario Health

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About Public Health Ontario

Public Health Ontario is an agency of the Government of Ontario dedicated to protecting and promoting the health of all Ontarians and reducing inequities in health. Public Health Ontario links public health practitioners, front-line health workers and researchers to the best scientific intelligence and knowledge from around the world. For more information about Public Health Ontario, visit publichealthontario.ca.

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Highlights

This report provides estimates of the prevalence of smoking and alcohol consumption, as well as smoking and alcohol attributable deaths, hospitalizations and emergency department visits by public health unit and across Ontario. The population attributable deaths (based on 2014 to 2018 data), hospitalizations (2015 to 2019 data) and emergency department visits (2015 to 2019 data) were calculated with the most recent years of usable data available at the time of analysis. The report also includes a discussion of tobacco and alcohol control strategies to prevent and reduce smoking and alcohol consumption, which may be adopted by individual public health units based on their circumstances and contexts.

Prevalence of smoking

During the 2015 to 2017 period, 17.5 per cent of people in Ontario age 20 and older reported that they currently smoke cigarettes every day or occasionally. The prevalence of current smoking among Ontario's 34 public health units ranged from a low of 12.3 per cent to a high of 28.0 per cent.

Estimated health outcomes attributable to smoking

In an average year, an estimated 16,673 deaths, 68,046 hospitalizations and 125,384 emergency department visits were attributable to smoking in people age 35 and older. These smoking attributable outcomes made up 17.0 per cent of deaths, 8.7 per cent of hospitalizations and 3.4 per cent of emergency department visits from all causes in people age 35 and older in Ontario. All of these outcomes were more common in males than females.

Prevalence of alcohol consumption

During the 2015 to 2017 period, 76.8 per cent of people in Ontario age 15 and older reported current drinking, which is defined as having one or more drinks in the past 12 months. The prevalence of current drinking among Ontario's 34 public health units ranged from a low of 63.2 per cent to a high of 83.3 per cent.

During the same 2015 to 2017 period, 18.9 per cent of people in Ontario age 15 and older reported binge drinking, which is defined as five or more drinks for males and four or more drinks for females on one occasion at least once a month in the past 12 months. The prevalence of binge drinking in the public health units ranged from a low of 13.3 per cent to a high of 28.4 per cent.

During the same time period, 33.2 per cent of people in Ontario age 19 and older reported having more than two drinks in the past week. While no amount of alcohol consumption is risk free, more than two drinks per week increases risk beyond a low level, with each additional drink increasing risk further. The prevalence of exceeding two drinks per week among the public health units ranged from 23.5 per cent to 42.6 per cent.

Estimated health outcomes attributable to alcohol

In an average year, an estimated 4,330 deaths, 22,009 hospitalizations and 194,692 emergency department visits were attributable to alcohol in people age 15 and older. These alcohol attributable outcomes made up 4.3 per cent of deaths, 2.1 per cent of hospitalizations and 3.7 per cent of emergency department visits from all causes in people age 15 and older in Ontario. All of these outcomes were more common in males than females.

See appendix A at ontariohealth.ca/smoking-alcohol for a presentation of estimated health outcomes for public health units.

Foreword

On behalf of Ontario Health and Public Health Ontario we are pleased to present the *Burden of Health Conditions Attributable to Smoking and Alcohol by Public Health Unit in Ontario*. This report provides data and evidence that illustrate the burden of disease and injury attributable to smoking and alcohol consumption in Ontario. This information is important to decision makers and Ontarians because it supports targeted policies and programs for preventing these harms to people and the health system. Estimates of the prevalence of smoking and alcohol use in the province are presented along with estimates of the smoking and alcohol attributable deaths, hospitalizations and emergency department visits. This report builds on the 2019 [Burden of Chronic Diseases in Ontario](#) report by providing data at the public health unit level in addition to Ontario level data on harms related to smoking and alcohol use.

Each year on average in Ontario, smoking attributable harms have been responsible for approximately 16,673 deaths, 68,046 hospitalizations and 125,384 emergency department visits. These smoking attributable outcomes made up 17.0 per cent of deaths, 8.7 per cent of hospitalizations and 3.4 per cent of emergency department visits from all causes in Ontario. Alcohol attributable harms have been responsible for approximately 4,330 deaths, 22,009 hospitalizations and 194,692 emergency department visits. These alcohol attributable outcomes made up 4.3 per cent of deaths, 2.1 per cent of hospitalizations and 3.7 per cent of emergency department visits from all causes in Ontario. Together, smoking and alcohol attributable harms and injuries present a considerable burden on the health care system. In Ontario, the total direct health care costs and indirect costs are estimated to be \$7.0 billion a year for smoking and \$4.5 billion for alcohol consumption.(1) These harms can be prevented through targeted policy, population-based and clinical interventions that are tailored to local public health unit estimates of prevalence and outcomes.

This report supports [Ontario Health's Chronic Disease Prevention Strategy 2020 to 2023](#) and [Public Health Ontario's Strategic Plan, 2020–2023](#). For more data and evidence on chronic diseases and their risk factors, please visit the [Ontario Health](#) and [Public Health Ontario](#) websites.

Ontario Health and Public Health Ontario welcome the opportunity to continue working with our partners to improve data reporting, reduce exposure to chronic disease risk factors and address health inequities in Ontario.

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Introduction

Purpose

This report, produced collaboratively by Ontario Health and Public Health Ontario, presents Ontario-wide smoking and alcohol attributable harms, which are defined as deaths, hospitalizations and emergency department visits associated with smoking and alcohol attributable health conditions. This report also presents harms at the public health unit level to support local system planning and opportunities for policy development to prevent and reduce smoking and alcohol consumption.

Background

Smoking tobacco and alcohol consumption, along with physical inactivity and an unhealthy diet, are the four most common modifiable and preventable risk factors for major non-communicable diseases.(2)

In Canada, smoking is the most common cause and alcohol is the sixth most common cause of disability and death.(3) It has been estimated that 45,000 deaths per year are due to smoking (4) and 15,000 are due to alcohol consumption.(5, 6) In 2017, alcohol and smoking contributed almost 89 per cent of total substance use health care costs in the country.(7)

Considering the substantial burden of disease attributable to smoking and alcohol consumption, a detailed examination of harms due to smoking and alcohol in Ontario is warranted. Because Ontario is a large and diverse province, it is also important to look at mortality and morbidity at the public health unit level. A better understanding of region-specific smoking and alcohol attributable outcomes can help health care providers and public health professionals prioritize efforts to reduce smoking and alcohol consumption in their communities. By reducing the prevalence of smoking and alcohol consumption, there is potential to reduce the burden of disease in Ontario, keeping the people in Ontario healthier and reducing overall health care use and costs.(8)

Smoking in this report refers to smoking cigarettes and does not include any other forms of tobacco, such as chew, waterpipe or vaping. It does not include smoking non-tobacco products, such as cannabis. The harms described in this report are only associated with commercial tobacco use for recreational purposes and are not associated with the sacred and traditional uses of tobacco. Smoking was reported for people age 20 and older to align with other reporting standards and guidelines, such as those from the Association of Public Health Epidemiologists in Ontario, Public Health Ontario Snapshots and Ontario Cancer Profiles.

Current drinking in this report is defined as having one or more alcoholic drinks in the past 12 months. Measuring drinking behaviours in people age 15 and older is common for alcohol consumption surveillance. For example, the age 15 and older population was used by Canada's Chief Public Health Officer in the Report

on the State of Public Health in Canada 2015.(9) This population is also used in global alcohol consumption monitoring by the World Health Organization.(9-11) Heavy drinking or binge drinking is defined as five or more drinks for males and four or more drinks for females on one occasion at least once a month in the past 12 months.

In January 2023, the Canadian Centre on Substance Use and Addiction released Canada’s Guidance on Alcohol and Health, which replaces Canada’s Low-Risk Alcohol Drinking Guidelines.(12) The new guidance is based on updated evidence that shows all levels of alcohol consumption are associated with increased risk of alcohol-related harms. The new guidance proposes that there is a continuum of risk where the risk is low for those who consume two standard drinks or less per week; the risk is moderate for those who consume three to six standard drinks per week; and it is increasingly high risk for those who consume seven or more standard drinks per week.

Due to data and scope limitations, some topics will not be examined in this report, such as the greater burden of disease from smoking and alcohol experienced by certain segments of the population, and regional differences in sociodemographic factors that impact risk factor prevalence and health outcomes. Exposure to second-hand smoke and vaping, fetal alcohol spectrum disorder and certain social harms are also out of scope.

Only harms partially or fully attributable to smoking and alcohol were included in this report. Although there is evidence that smoking and alcohol negatively impact overall health, only conditions that have a direct association were counted.

Emerging evidence on the COVID-19 pandemic suggests that chronic conditions, such as cancer, heart disease, diabetes and chronic kidney disease, may increase the severity of COVID-19,(13) plus the pandemic has had a significant impact on chronic disease prevention and health care use. It has also disproportionately impacted people of lower socioeconomic status, and people of certain ethnicities and races. An examination of the impact of COVID-19 on smoking and alcohol attributable harms was not possible in this report because data were only available up to 2019 at the time of analysis. When data become available, future research is warranted on the substantial impact of the COVID-19 pandemic on chronic disease prevention and health outcomes.

In addition, this report does not quantify the synergistic harms created when smoking and alcohol are combined. The increase in risk of disease becomes much greater when someone smokes cigarettes and drinks alcohol together, compared to the sum of the risks from smoking and drinking separately. Although the synergistic effect between smoking and alcohol is an important factor to consider, there are no risk estimates quantifying the effect. Therefore, this report presents risk estimates for smoking and alcohol separately. These risk estimates are more conservative than they would be for a combined synergistic risk; hence they may represent an underestimate of these harms.

Finally, the terms used to refer to sex in this report (male, female, men and women) come from the report's data sources and do not represent the full gender diversity found in Ontario's population.

Health conditions attributable to smoking and alcohol

This section provides a brief overview of the health conditions caused by smoking and alcohol consumption.

Cancer

Cancer refers to a group of diseases in which abnormal cells begin to grow out of control.(14) It has been estimated that 33 per cent of cancer cases diagnosed in 2015 in Canada were attributable to modifiable risk factors.(15) Smoking has long been classified as carcinogenic by the International Agency for Research on Cancer and is responsible for the largest proportion of preventable cancers.(16-19) Smoking causes cancers of the oral cavity, pharynx, naso-pharynx, nasal cavity, para-nasal sinuses, larynx, esophagus, stomach, colon and rectum, liver, pancreas , cervix (as a co-factor with human papillomavirus), ovary, kidney, bladder and other urinary system (including ureter), bone marrow (acute myeloid leukemia) and lung.(20) Although not all lung cancers are caused by smoking, the greatest proportion of preventable lung cancers can be attributed to smoking. There is evidence that smoking is a probable cause of breast cancer.(21, 22)

Alcoholic beverages have also been classified as carcinogenic by the International Agency for Research on Cancer, causing cancers of the oral cavity, pharynx, larynx, esophagus (primarily squamous cell carcinoma), colon and rectum, female breast (post-menopausal), pancreas and liver.(16-19, 23-26) There is evidence that alcohol consumption is a probable risk factor for pre-menopausal breast cancer and stomach cancer.(25) Although some evidence suggests that having up to two alcoholic drinks per day probably protects against kidney cancer, any potential benefit is far outweighed by the increased risk of developing other cancers.(25) For all cancers associated with alcohol, evidence shows that there is a dose–response relationship, with increasing risk as levels of consumption rise.(24) Studies have shown that for some cancers there is no safe minimum level of alcohol consumption, whereas for others, the risk increases markedly at higher levels of consumption (more than two or three drinks per day).(25) Binge or heavy drinking (consuming four or more alcoholic drinks per day) substantially increases the risk of developing cancer.(23, 24)

A synergistic interaction between alcohol and smoking has been observed for some cancers. The risk of developing cancers of the oral cavity, pharynx, larynx and esophagus (squamous cell carcinoma) among people who both drink alcohol and smoke is much greater than the sum of the risks among people who only smoke and people who only drink.(27) Evidence also suggests that the risk of these cancers is much higher among people who both drink and smoke heavily than among people who do not drink or smoke.(16, 27)

Cardiovascular diseases

Smoking and alcohol consumption have been associated with many cardiovascular diseases. Cardiovascular diseases include ischemic heart disease, hypertension, cerebrovascular disease, atherosclerosis, aortic aneurysm and other arterial disease.

Smoking has been shown to cause atherosclerosis, coronary heart disease and peripheral arterial disease.(28) Smoking also increases the risk of ischemic heart disease, stroke and abdominal aortic aneurysm.(28)

Regular heavy alcohol consumption (60 or more grams of pure alcohol, equivalent to five or more standard drinks, on one or more occasion at least once per month) is associated with adverse cardiovascular outcomes, including cardiomyopathy, systemic hypertension, hemorrhagic stroke, some forms of heart failure and overall cardiovascular mortality.(29, 30) Consuming more than four alcoholic drinks a day is associated with an increased risk of ischemic and haemorrhagic stroke.(31) Occasional heavy drinking (60 or more grams of alcohol per occasion) among people with low-to-moderate alcohol consumption (less than three standard-sized drinks per day) is also associated with cardiovascular disease.(32) People who drink moderately and occasionally drink heavily have an increased risk of ischemic heart disease, compared to people who only drink moderately.(33)

Despite the many detrimental effects of alcohol, some studies have shown protective effects when consumed at low levels.(34, 35) Low-to-moderate alcohol consumption (less than three standard-sized drinks per day) with no heavy drinking may be related to decreases in overall cardiovascular disease mortality, and lower risks of ischemic heart disease and ischemic stroke.(29, 30, 32, 36) However, recent research has strongly contested the protective effects observed in some studies.(37, 38) It is also important to consider that even if there is a protective effect for specific health conditions, alcohol consumption at any level is harmful for overall health.(39)

Consuming three or more drinks per day has similar adverse effects as smoking on some forms of cardiovascular disease. However, it is unclear whether there is a synergistic effect on cardiovascular disease (i.e., a multiplicative increase in risk if someone smokes and drinks at the same time).(34) Examples of the adverse effects of alcohol include increases in blood pressure and levels of triglycerides in the blood, and a higher risk of stroke and congestive heart failure.(34) The proportion of cardiovascular diseases that could be prevented by reducing risk factors such as smoking and alcohol consumption varies.(8, 40, 41)

Respiratory diseases

Chronic obstructive pulmonary disease (COPD) refers to a group of preventable lung diseases, including emphysema and chronic bronchitis, and is the third leading cause of death worldwide.(42, 43) Smoking is the leading cause of COPD morbidity and mortality.(28, 43) Deaths attributed to COPD may be underestimated

by as much as 50 per cent because they are often recorded as deaths from other conditions, such as pneumonia and cardiovascular diseases.(42, 44, 45)

Smoking and alcohol consumption are also risk factors for lower respiratory infections, such as pneumonia. Smoking has been associated with community-acquired pneumonia, especially in people with COPD.(46, 47) Evidence suggests that there is a dose–response relationship between higher amounts of tobacco smoked and higher risk of community-acquired pneumonia.(46) Alcohol consumption has also been associated with community-acquired pneumonia, with people who drink heavily having a greater risk for poor outcomes.(48, 49)

Tuberculosis is an infectious disease caused by a bacterium (*Mycobacterium tuberculosis*) that primarily affects the lungs, but also affects other parts of the body, such as the kidneys, spine and brain. Smoking has been shown to increase the risk of getting tuberculosis and dying from tuberculosis, plus smoking can decrease the effectiveness of treatment for tuberculosis.(50-52) In addition, heavy drinking and alcohol consumption disorders have been strongly linked to an increased risk of tuberculosis infection and active tuberculosis, as well as decreased treatment efficacy.(53)

Influenza is an infectious respiratory condition caused by influenza viruses that affects the nose, throat and lungs. Some studies have shown that smoking increases the risk of infection and hospital admissions from influenza.(54, 55)

Human immunodeficiency virus/acquired immunodeficiency syndrome

There is some evidence to suggest that alcohol is associated with the transmission of human immunodeficiency virus/acquired immunodeficiency syndrome as well as a higher incidence of disease. The association may be explained by biological (effect of alcohol on disease progression and transmission) and behavioural factors (decision-making and sexual and risk-taking behaviours).(56, 57)

Diabetes

Diabetes is a condition that prevents the production of enough insulin or the proper use of insulin, which is needed to regulate the amount of sugar in the body.(58) Deaths from diabetes may be underestimated because having diabetes increases the risk of dying from other conditions, including cardiovascular diseases and colorectal cancer.(59, 60)

Smoking has been recognized as a preventable and modifiable risk factor for type 2 diabetes. Population-based studies have shown that smoking may increase the risk of type 2 diabetes by 30 to 40 per cent for people who currently smoke, compared to people who do not smoke.(28, 61)

Regular heavy alcohol consumption is also associated with type 2 diabetes. Although some evidence shows that low-to-moderate alcohol consumption with no heavy drinking may be related to decreases in type 2 diabetes, (29, 30, 32, 36, 62, 63) recent studies call into question the protective effects of alcohol observed

by some researchers.(64-66) Even if there is a protective effect for diabetes, alcohol consumption at any level is harmful for overall health.(39)

Neuropsychiatric conditions

Neuropsychiatric conditions refer to a broad range of mental, neurologic and substance use conditions.(30) Although many people living with mental health conditions can become dependent on alcohol or develop a use disorder, the directionality of the relationship is unclear as cause is very difficult to establish.(67, 68) One of the neuropsychiatric conditions that has a clear association with alcohol consumption is epilepsy, which is defined as an enduring predisposition for epileptic seizures.(69) A consistent dose–response relationship is seen for epilepsy and alcohol, particularly at higher levels of consumption,(32, 69, 70) with evidence to suggest that alcohol may cause seizures.(71, 72) People drinking higher levels of alcohol are also at risk of experiencing alcohol psychoses, alcohol use disorder, alcohol polyneuropathy, alcohol myopathy and degeneration of the nervous system.

Other neurological conditions may be related to alcohol consumption, but the association is not well established in the literature. These conditions include Wernicke encephalopathy, Korsakoff syndrome, ventricular enlargement and cognitive dysfunction, alcoholic cerebellar degeneration and neuromuscular complications (e.g., peripheral neuropathy and myopathy).

Digestive conditions

Digestive conditions refer to a variety of conditions that affect the gastrointestinal tract, which includes the esophagus, liver, stomach, small and large intestines, gallbladder and pancreas. Heavy drinking has been shown to have the greatest effect on diseases of the liver and the pancreas.

Evidence suggests that there is a dose–response relationship between alcohol consumption and fatty liver disease, alcohol hepatitis and cirrhosis.(69) Multiple studies show that higher alcohol consumption leads to an exponential increase in the risk of developing these conditions.(67, 73) There is also research showing that alcohol consumption is more likely to cause cirrhosis mortality than morbidity because heavy drinking has been shown to worsen cirrhosis from other causes.(32, 73)

Acute and chronic pancreatitis has been linked to alcohol consumption.(67, 73) Specifically, heavy drinking has been shown to greatly increase the risk of developing pancreatitis, whereas lower levels of alcohol consumption are associated with only a small increase in risk.(32, 69)

Injuries

Many types of injuries are associated with alcohol consumption. Both intentional and unintentional injuries have been strongly linked to blood alcohol concentration and its impact on psychomotor abilities. Higher levels of alcohol consumption have been shown to cause an exponential increase in risk of injury and even low levels of consumption increases risk compared with no consumption.(67, 74)

The impact of alcohol on psychomotor abilities can lead to unintentional injuries such as drownings, burns, poisonings and falls.(67) Impaired driving is the leading cause of alcohol-related injuries with a clear causal link.(30, 67, 74)

Intentional injuries can also result from alcohol consumption.(39, 67) Alcohol consumption, especially heavy drinking, has been causally linked to suicide and violence.(75) A clear association between alcohol and aggression has been established, which may lead to injuries related to assault, suicide, intimate partner violence and homicide.(30, 32, 67) Regular alcohol consumption and elevated blood alcohol levels have specifically been shown to increase suicide risk.(67)

Methods

Data sources

Multiple data sources were used to develop the key estimates of alcohol and smoking attributable harms in Ontario, which are described in Table 1. The technical appendix provides a detailed description of the methodology used to produce the prevalence estimates and the population attributable fractions. In addition, supplementary tables are available for all the data that contributed to the estimates presented in this report.

Table 1: Data sources

Data source	Estimate	Notes
Vital Statistics – Death, Ontario Registrar General 2014–2018	Deaths	Most recent year of data available at time of analysis was 2018.
Discharge Abstract Database – Inpatient Discharges, IntelliHEALTH ONTARIO, Ontario Ministry of Health 2015–2019 Ontario Mental Health Reporting System – Inpatient Mental Health Discharges, IntelliHEALTH ONTARIO, Ontario Ministry of Health 2014–2018	Hospitalizations	Most recent year of population estimates available at time of analysis was 2019. Most recent year of population estimates available at time of analysis was 2018.
National Ambulatory Care Reporting System – Emergency department visits,	Emergency department visits	Most recent year of population estimates available at time of analysis was 2019.

Data source	Estimate	Notes
IntelliHEALTH ONTARIO, Ontario Ministry of Health 2015–2019		
Canadian Community Health Survey, Statistics Canada 2015–2017	Prevalence of risk factors (self-reported)	<p>Most recent cycles of data available at time of analyses were from the 2015/2016 and 2017 cycles.</p> <p>Estimates were produced from the Canadian Community Health Survey share file from Statistics Canada.</p> <p>The Canadian Community Health Survey was redesigned in 2015, prohibiting direct comparisons with earlier Canadian Community Health Survey cycles.</p>

Calculating the prevalence of smoking and drinking

Responses from the 2015 to 2017 Canadian Community Health Surveys were used to estimate the prevalence of current smoking, current drinking, binge drinking and exceeding two drinks per week. Prevalence estimates, reported as percentages, were calculated as the survey-weighted number of people in the relevant age range who reported each behaviour, divided by the total number of people in that age range, multiplied by 100. Each prevalence estimate was calculated at the Ontario level and for each of the 34 public health units. Prevalence estimates (crude rates) for smoking and alcohol consumption are presented in this report for Ontario as a whole and by public health unit. Prevalence estimates of smoking and alcohol consumption (crude and age-standardized) are available by Local Health Integration Network through Public Health Ontario’s online tool [Snapshots](#) or through Ontario Health’s [Ontario Cancer Profiles](#). Estimates may be calculated for other geographic boundaries using the methodology provided in the accompanying technical appendix.

The prevalence of current smoking was calculated as the percentage of people age 20 and older who reported daily or occasional cigarette smoking. The prevalence of current drinking was calculated as the percentage of people age 15 and older who reported consuming at least one alcoholic drink in the past 12 months. The prevalence of binge drinking was calculated as the percentage of people age 15 and older who reported consuming four or more drinks if female or five or more drinks if male on one occasion at least once a month in the past 12 months. The prevalence of people exceeding two drinks per week was calculated as the percentage of people age 19 and older who reported consumption of more than two drinks in the past

week. The methodology and exclusion criteria used to calculate these prevalence estimates can be found in the technical appendix.

An overview of attributable harms methodology

Attributable harms calculations involve estimating the proportion of an outcome (e.g., deaths) that are caused by smoking or alcohol consumption in a population. For this calculation, estimates on the prevalence of population exposure come from the Canadian Community Health Survey (e.g., the proportion of people currently, formerly and never smoking in Ontario). Risk relationships between the epidemiological exposure of interest (smoking and alcohol consumption) and the outcomes of interest (mortality and morbidity) come from the literature (e.g., the relative risk of dying from lung cancer among people currently smoking versus non-smoking and former smoking versus non-smoking).(28) Data on smoking and alcohol attributable outcomes come from vital statistics or health care administrative data such as the Discharge Abstract Database and the National Ambulatory Care Reporting System. Finally, using Levin’s formula for calculating smoking attributable fractions (see the technical appendix) or the International Model of Alcohol Harms and Policies (InterMAHP) for calculating alcohol attributable fractions, the risk relationships are combined with population exposures and outcomes to calculate smoking and alcohol population attributable fractions.

Population attributable fractions represent the proportion of each condition’s outcome (e.g., deaths from lung cancer) that would not have occurred in the absence of exposure to the substance of interest (e.g., smoking). Population attributable fractions are then applied to the outcome counts across all health conditions to arrive at estimates of the smoking attributable and alcohol attributable harms in each geographic area.

Calculating smoking attributable harms

Smoking population attributable fractions were calculated for mortality (i.e. deaths), hospitalizations and emergency department visits for each health condition using Levin's formula (17), with the prevalence of current smoking, the prevalence of former smoking, the disease-specific relative risk for current smoking versus never-smoking, and the disease-specific relative risk of harms for former smoking versus never smoking as inputs. The condition categories and International Classification of Diseases, Tenth Revision (ICD-10) codes are shown in Table 2.

Table 2: Condition categories and diagnosis codes for smoking

Conditions	ICD-10 codes
Diabetes	E10–E14
Lung cancer	C33–C34
Other cancers	—
Lip and oral cavity	C00–C14
Esophagus	C15
Stomach	C16
Colon and rectum	C18–C20, C26.0
Liver	C22
Pancreas	C25
Larynx	C32
Cervix uteri	C53
Kidney and renal pelvis	C64–C65
Urinary bladder	C67
Acute myeloblastic leukemia	C92.0
Cardiovascular diseases	—
Ischemic heart disease	I20–I25
Other heart disease	I00–I09, I11, I13, I26–I51
Cerebrovascular disease	I60–I69
Atherosclerosis	I70
Aortic aneurysm	I71
Other arterial disease	I72–I78
Respiratory diseases	—
Tuberculosis	A15–A19
Influenza	J10–J11
Pneumonia	J12–J18
Bronchitis	J40–J42
Other chronic obstructive pulmonary disease	J44

ICD-10 = International Classification of Diseases, Tenth Revision

For each health condition associated with smoking, the smoking population attributable fraction was calculated at the provincial level by sex and age group (35 to 54, 55 to 64, 65 to 74, and 75 and older), using age- and sex-specific relative risks and prevalence estimates. Age- and sex-specific relative risks for health condition subgroups were from the American Cancer Society's Cancer Prevention Study II and pooled data

from five large contemporary cohort studies.(28) Prevalence estimates of smoking for Ontario by age and sex were derived from the 2015 to 2017 cycles of the Canadian Community Health Survey.(76-78)

The most recent five years of data available were used to calculate the average annual total number of deaths, hospitalizations and emergency department visits for each health outcome. Data on deaths came from 2014 to 2018 Vital Statistics (Office of the Ontario Registrar General). Hospitalization data came from the Discharge Abstract Database (IntelliHealth) for 2015 to 2019.(79) Data on emergency department visits came from the National Ambulatory Care Reporting System (IntelliHealth) for 2015 to 2019.(80) Data on mortality, hospitalizations and emergency department visits for lung cancer, other cancers, cardiovascular diseases, respiratory diseases and diabetes were extracted by sex for the following age groups: 35 to 54, 55 to 64, 65 to 74, and 75 and older. Mortality (i.e., deaths) or morbidity (i.e., hospitalizations or emergency department visits) counts for each of the disease categories were extracted by public health unit. To calculate the total number of smoking attributable outcomes for each health condition by public health unit, the provincial age- and sex-specific smoking population attributable fractions were multiplied by the total number of outcomes in each sex and age group for each public health unit and then summed. More detailed results, including the smoking population attributable fractions for each of the health condition subcategories, are shown in the supplementary tables.

The tables in the results section show the number of each of these outcomes estimated to be attributable to smoking in an average year over the five-year timespan shown for each of the health condition categories in Ontario. The results for each of the 34 public health units are available in appendix A at ontariohealth.ca/smoking-alcohol.

Calculating alcohol attributable harms

Alcohol population attributable fractions for mortality, hospitalizations and emergency department visits were calculated for each health condition category using InterMAHP.(81-84) InterMAHP is an open access alcohol harms estimator and policy scenario modeller developed by the Canadian Institute for Substance Use Research at the University of Victoria. InterMAHP standardizes the core methodology of calculating alcohol population attributable fractions, while allowing for customization according to regional patterns of alcohol consumption. Although calculation of the smoking population attributable fractions had to be programmed manually, InterMAHP allowed for a more efficient and less duplicative method of calculating alcohol population attributable fractions.

Alcohol population attributable fractions for mortality, hospitalizations and emergency department visits were calculated for 44 health conditions using age and sex specific relative risks and prevalence estimates, which were then grouped into the following nine categories: cancer, cardiovascular diseases, communicable diseases, digestive conditions, endocrine conditions, neuropsychiatric conditions, unintentional injuries, intentional injuries (including self-harm) and motor vehicle collisions. The communicable diseases category comprises mostly lower respiratory tract infections and tuberculosis, with the only non-respiratory disease in this category being human immunodeficiency virus, type 1. The endocrine disorders category is almost

entirely made up of diabetes, with the other endocrine disorders comprising a small number of cases of alcohol-induced pseudo-Cushing’s syndrome. The subcategories of health conditions are shown in Table 3.

Table 3: Condition categories and diagnosis codes for alcohol

Conditions	ICD-10 and DSM-IV/DSM-5 codes*
Cancer	—
Oral cavity and pharynx cancer	C00–C05, C08–C10, C12–C14, D00.0
Esophageal cancer, squamous cell carcinoma	C15, D00.1 (portional only)
Colorectal cancer	C18–C21, D01.0–D01.4
Liver cancer	C22, D01.5
Pancreatic cancer	C25, D01.7
Laryngeal cancer	C32, D02.0
Breast cancer	C50, D05
Cardiovascular diseases	—
Hypertension	I10–I15
Ischemic heart disease	I20–I25
Alcoholic cardiomyopathy	I42.6
Atrial fibrillation and cardiac arrhythmia	I47–I49
Hemorrhagic stroke	I60–I62, I69.0–I69.2
Ischemic stroke	I63–I67, I69.3–I69.4
Esophageal varices	I85
Communicable diseases	—
Tuberculosis	A15–A19
Human immunodeficiency virus	B20–B24, Z21
Lower respiratory tract infections	J09–J22
Digestive conditions	—
Alcoholic gastritis	K29.2
Liver cirrhosis	K70, K74
Acute pancreatitis	K85.0–K85.1, K85.8–K85.9
Chronic pancreatitis	K86.1–K86.9
Alcohol-induced pancreatitis	K85.2, K86.0
Endocrine conditions	—
Diabetes mellitus, type 2	E11, E13, E14

Conditions	ICD-10 and DSM-IV/DSM-5 codes*
Alcohol-induced pseudo-Cushing's syndrome	E24.4
Neuropsychiatric conditions	—
Alcoholic psychoses, intoxication, withdrawal, amnesic syndrome, other mental and behavioural disorders	F10.0, F10.3–F10.9
Alcohol abuse	F10.1
Alcohol dependence syndrome	F10.2
Degeneration of nervous system due to alcohol	G31.2
Epilepsy	G40, G41
Alcoholic polyneuropathy	G62.1
Alcoholic myopathy	G72.1
Neuropsychiatric conditions coded using DSM IV and DSM V**	—
Alcohol-induced anxiety/mood disorder or sexual dysfunction	29189
Alcohol-induced psychotic disorder, with delusions	29150
Alcohol-induced psychotic disorder, with hallucinations	29130
Alcohol-induced persisting dementia	29120
Alcohol abuse	30500
Alcohol intoxication	30300
Alcohol-related disorder NOS	29190
Alcohol intoxication or withdrawal delirium	29100
Alcohol dependence	30390
Alcohol withdrawal	29181
Alcohol-induced sleep disorder	29182
Alcohol-induced persisting amnesic disorder	29110
Unintentional injuries	—
Falls	W00-W19, Y30
Drowning	W65–W74
Fires	X00–X09, Y26
Accidental poisoning by substances other than alcohol	T36–T50, T52–T65, T96–T97, X40–X44, X46–X49, Y10–Y14, Y16–Y19

Conditions	ICD-10 and DSM-IV/DSM-5 codes*
Accidental poisoning by alcohol	T51, X45, Y15
Other unintentional injuries	V*** codes not specified in motor vehicle collisions section, W20–W64, W75–W84, X10–X33, Y20, Y22–Y25, Y27–Y29, Y31–Y34, Y85.9, Y86, Y87.2, Y89.9
Intentional injuries	—
Intentional self poisoning by substances other than alcohol	T36–T50, T52–T65, T96–T97, X60–X64, X66–X69
Intentional self poisoning by alcohol	T51, X65
Other intentional self-harm	X70–X84, Y87.0
Assault/homicide	X85–Y09 Y87.1
Other intentional injuries	Y35, Y89.0
Motor vehicle collisions	—
Motor vehicle collisions	V02.1, V02.9, V03.1, V03.9, V04.1, V04.9, V09.2, V09.3, V12.3–V12.9, V13.3–V13.9, V14.3–V14.9, V19.4, V19.5, V19.6, V19.9, V20.3–V20.9, V21.3–V21.9, V22.3–V22.9, V23.3–V23.9, V24.3–V24.9, V25.3–V25.9, V26.3–V26.9, V27.3–V27.9, V28.3–V28.9, V29.4, V29.5, V29.6, V29.9, V30.4–V30.9, V31.4–V31.9, V32.4–V32.9, V33.4–V33.9, V34.4–V34.9, V35.4–V35.9, V36.4–V36.9, V37.4–V37.9, V38.4–V38.9, V39.4, V39.5, V39.6, V39.9, V40.4–V40.9, V41.4–V41.9, V42.4–V42.9, V43.4–V43.9, V44.4–V44.9, V45.4–V45.9, V46.4–V46.9, V47.4–V47.9, V48.4–V48.9, V49.4, V49.5, V49.6, V49.9, V50.4–V50.9, V51.4–V51.9, V52.4–V52.9, V53.4–V53.9, V54.4–V54.9, V55.4–V55.9, V56.4–V56.9, V57.4–V57.9, V58.4–V58.9, V59.4, V59.5, V59.6, V59.9, V60.4–V60.9, V61.4–V61.9, V62.4–V62.9, V63.4–V63.9, V64.4–V64.9, V65.4–V65.9, V66.4–V66.9, V67.4–V67.9, V68.4–V68.9, V69.4, V69.5, V69.6, V69.9, V70.4–V70.9, V71.4–V71.9, V72.4–V72.9, V73.4–V73.9, V74.4–V74.9, V75.4–V75.9, V76.4–V76.9, V77.4–V77.9, V78.4–V78.9, V79.4, V79.5, V79.6, V79.9, V80.3, V80.4, V80.5, V81.1, V82.1, V83.4, V84.4, V85.4, V86.0, V86.1, V86.3, V87.0–V87.9, V89.2, V89.3, V89.9, Y85.0

DSM = Diagnostic and Statistical Manual of Mental Disorders; ICD-10 = International Classification of Diseases, Tenth Revision

Notes: Adapted from “Table 1. InterMAHP alcohol-attributable conditions with groupings, ICD-10 codes, and causation references.” (85)

*ICD-10 = International Classification of Diseases, Tenth Revision.

**Only the Ontario Mental Health Reporting System includes diagnoses coded using DSM IV and DSM V.

***All ICD-10 codes beginning with V that are not already listed in the Motor Vehicle Collisions section.

To calculate alcohol population attributable fractions for Ontario overall and each of Ontario’s 34 public health units, a dataset with alcohol consumption data and a dataset with mortality or morbidity data (i.e.,

hospitalizations or emergency department visits) were uploaded into InterMAHP. The alcohol consumption dataset included data by sex for the 15 to 34, 35 to 64, and 65 and older age groups at the Ontario level. For each age and sex group, the average consumption of alcoholic drinks per week was compared to the average consumption in males age 35 to 64 to create a ratio of average consumption. The alcohol consumption dataset also included prevalence of current drinking, prevalence of former drinking, prevalence of lifetime abstinence and prevalence of binge drinking. Prevalence of people binge drinking was used because binge drinking modifies alcohol's relationship with several outcomes (ischemic heart disease, ischemic stroke and injuries) and binge drinking was a required input by InterMAHP.(81-84) The following data were also required across all sex and age groups combined at the Ontario level: per capita consumption from alcohol sales, tourist consumption and unrecorded consumption. Data from alcohol sales were used to try to account for the underreporting of alcohol consumption that is common in survey data. The prevalence of alcohol consumption data and the relative consumption estimates were derived from the 2015 to 2017 cycles of the Canadian Community Health Survey.(76-78) Per capita consumption data were derived from 2015 to 2019 alcohol sales data from Statistics Canada and from 2016 to 2018 unrecorded consumption and tourist consumption data from the World Health Organization.(10, 11, 86)

The alcohol mortality and morbidity datasets uploaded to InterMAHP required counts of the number of deaths, hospitalizations or emergency department visits in each of the health condition subcategories shown in Table 3. These counts were required by sex for the 15 to 34, 35 to 64, and 65 and older age groups. Data on deaths came from 2014 to 2018 Vital Statistics (Office of the Ontario Registrar General). Hospitalization data were accessed from the Discharge Abstract Database (IntelliHealth) for 2015 to 2019 and the Ontario Mental Health Reporting System (IntelliHealth) for 2014 to 2018.(79, 87) Data on emergency department visits were accessed from the National Ambulatory Care Reporting System (IntelliHealth) for 2015 to 2019.(80)

When the relevant consumption and mortality or morbidity datasets were uploaded, estimates of the relative risk of each health condition from the Canadian Centre on Substance Use and Addiction and the Canadian Institute for Substance Use Research from 2017 were selected. These relative risks were identified in a number of studies, which are referenced in the technical appendix.(85) These disease-specific relative risk estimates were built into the InterMAHP tool. The following InterMAHP settings were then selected: unit of average daily consumption = grams-ethanol, upper limit of consumption = 250, dose-response extrapolation method = linear, binge definition for men = 67.3 (corresponding to five or more standard drinks per day), binge definition for women = 53.7 (corresponding to four or more standard drinks per day), squamous cell carcinoma proportion for men = 0.33 and squamous cell carcinoma proportion for women = 0.66. With the required data and settings selected, InterMAHP outputted datasets with the alcohol population attributable fractions for each of the health condition subcategories in each of the age and sex subgroups for each of the regions that were specified (Ontario overall and the 34 public health units). A detailed explanation of the methods employed by the InterMAHP tool are provided in the InterMAHP Guide, which is available at uvic.ca/research/centres/cisur/projects/intermahp/index.php.(88)

To calculate the total number of alcohol attributable outcomes for each health condition by public health unit, the provincial age and sex specific alcohol population attributable fractions from InterMAHP were multiplied by the total number of outcomes in each sex and age group for each public health unit and then summed. More detailed results, including the alcohol population attributable fractions for each of the health condition subcategories, are shown in the supplementary tables.

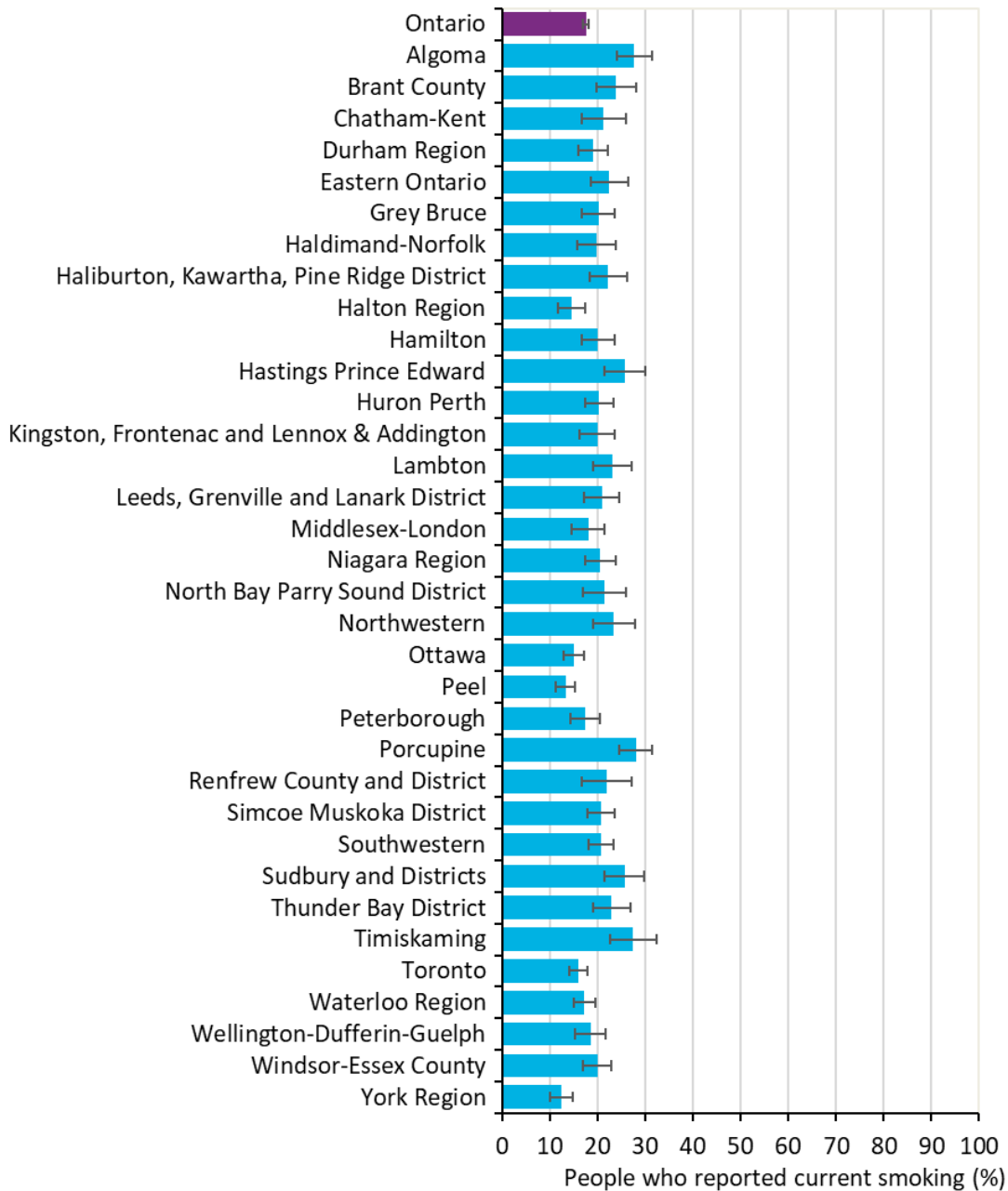
The tables in the results section show the number of each of these outcomes estimated to be attributable to alcohol in an average year over the five-year timespan shown for each of the health condition categories in Ontario. The results for each of the 34 public health units are available in appendix A at ontariohealth.ca/smoking-alcohol.

Results: Prevalence of smoking and alcohol consumption in Ontario

Smoking

During the 2015 to 2017 period, 17.5 per cent of people in Ontario age 20 and older reported that they currently smoke cigarettes every day or occasionally. The prevalence of current smoking among Ontario's 34 public health units ranged from a low of 12.3 per cent to a high of 28.0 per cent (see Figure 1 and Supplementary Table S1).

Figure 1: Percentage of people age 20 and older who reported current smoking, by public health unit, Ontario, 2015–2017 combined



Data sources: Canadian Community Health Survey, 2015/2016 cycle combined with 2017 annual component (Statistics Canada)

Data notes: |—| represents 95 per cent confidence intervals. Current smoking (age 20 and older) = respondents who are daily or occasional smokers. Data are presented in Supplementary Table S1. Download supplementary tables at ontariohealth.ca/smoking-alcohol.

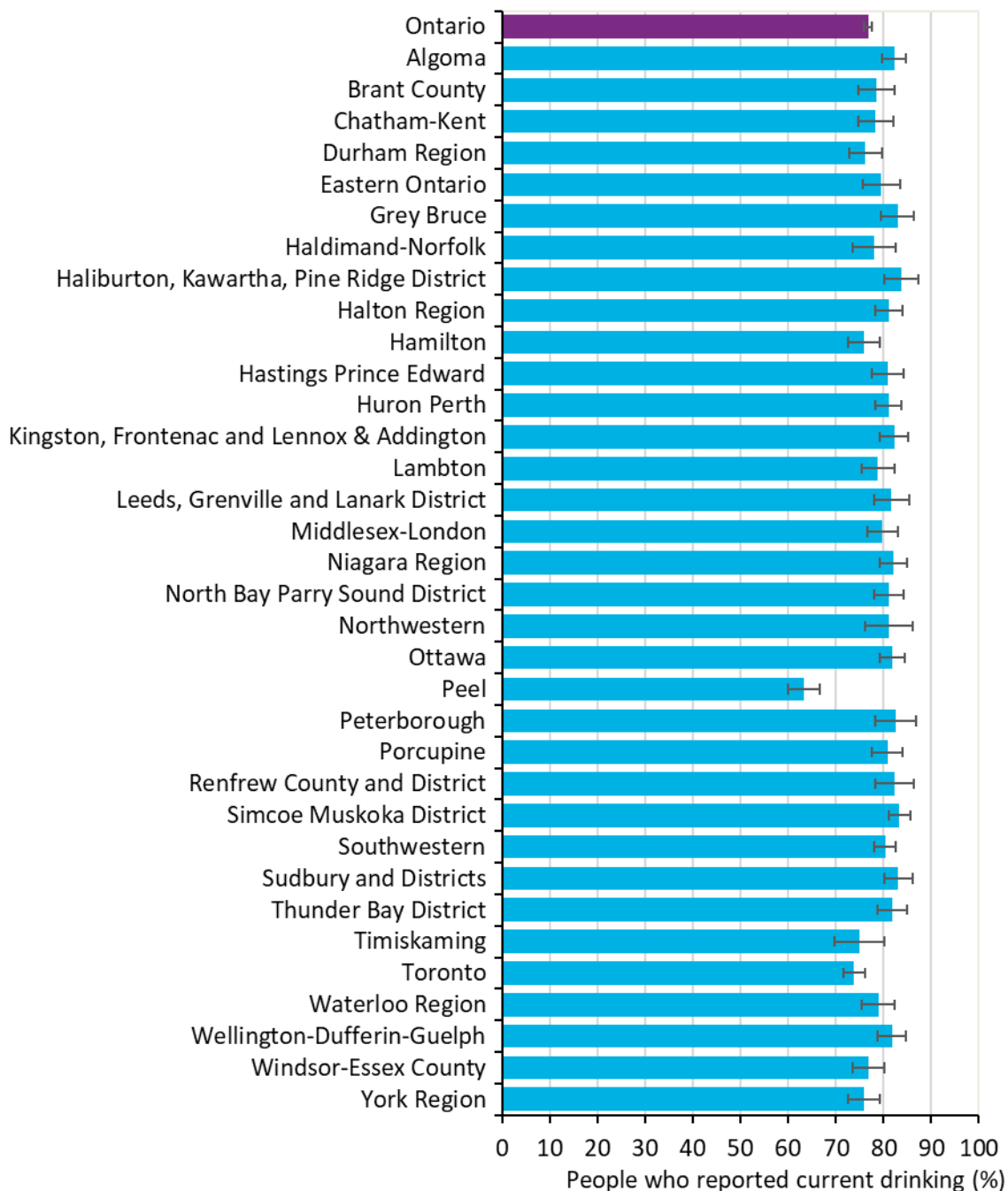
Alcohol consumption

During the 2015 to 2017 period, 76.8 per cent of people in Ontario age 15 and older reported current drinking, which is defined as having one or more drinks in the past 12 months. The prevalence of current drinking among Ontario's 34 public health units ranged from a low of 63.2 per cent to a high of 83.3 per cent (see Figure 2 and Supplementary Table S2).

During the same 2015 to 2017 period, 18.9 per cent of people in Ontario age 15 and older reported heavy or binge drinking, which is defined as five or more drinks for males and four or more drinks for females on one occasion at least once a month in the past 12 months. The prevalence of binge drinking in the public health units ranged from a low of 13.3 per cent to a high of 28.4 per cent (see Figure 3 and Supplementary Table S2). Among people who reported having one or more drinks in the past year (i.e., people who reported current drinking) the prevalence of binge drinking in the public health units ranged from a low of 18.0 per cent to a high of 35.2 per cent (data not shown).

During the same time period, 33.2 per cent of people in Ontario age 19 and older reported exceeding two drinks in the past week (see Figure 4 and Supplementary Table S2). The prevalence of people exceeding two drinks in the past week among Ontario's 34 public health units ranged from a low of 23.5 per cent to a high of 42.6 per cent (see Figure 4 and Supplementary Table S2).

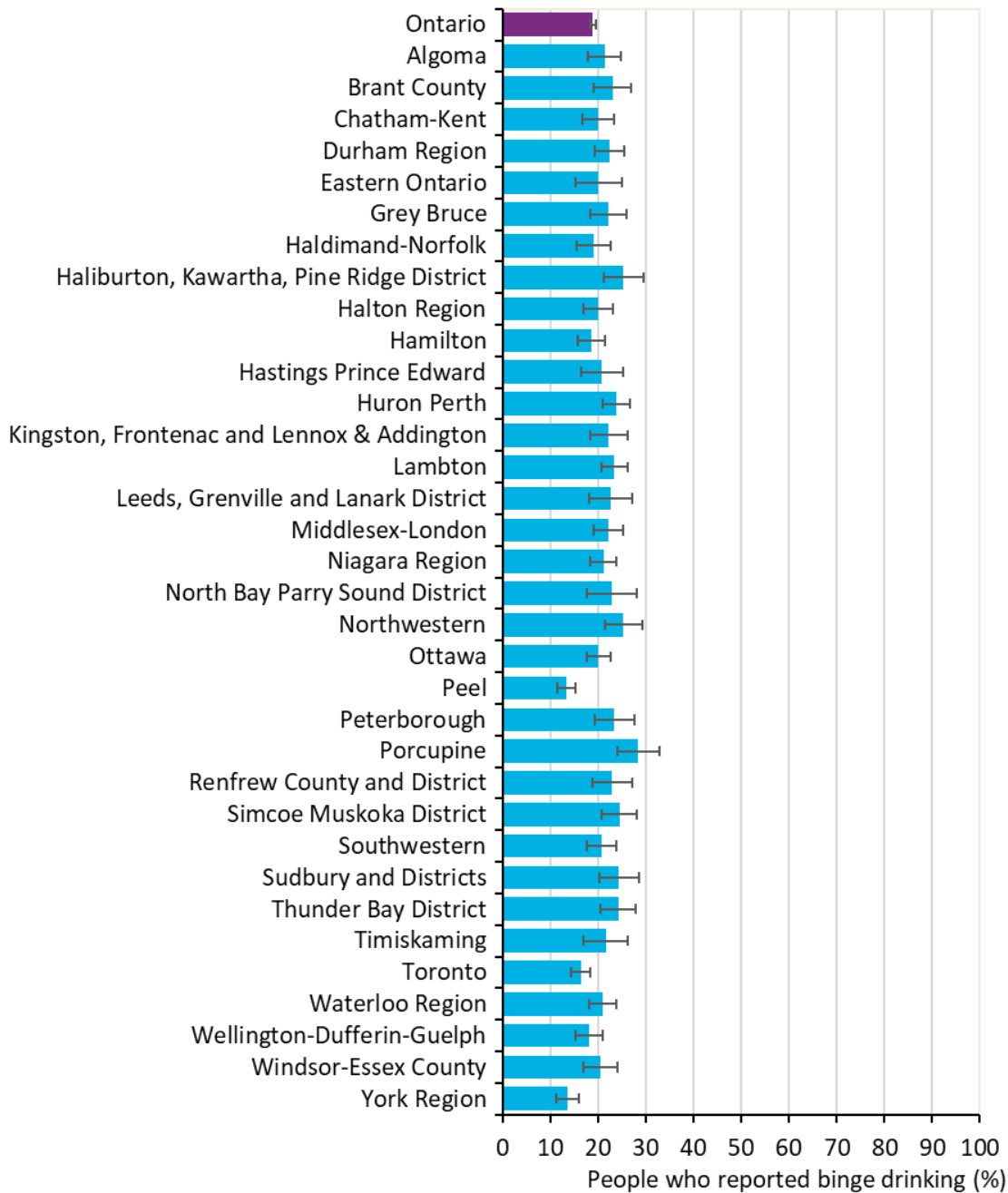
Figure 2: Percentage of people age 15 and older who reported current drinking, by public health unit, Ontario, 2015–2017 combined



Data sources: Canadian Community Health Survey, 2015/2016 cycle combined with 2017 annual component (Statistics Canada)

Data notes: |—| represents 95 per cent confidence intervals. Current drinking (age 15 and older) = respondents who reported having a drink in the past 12 months. Data are presented in Supplementary Table S2. Download supplementary tables at ontariohealth.ca/smoking-alcohol.

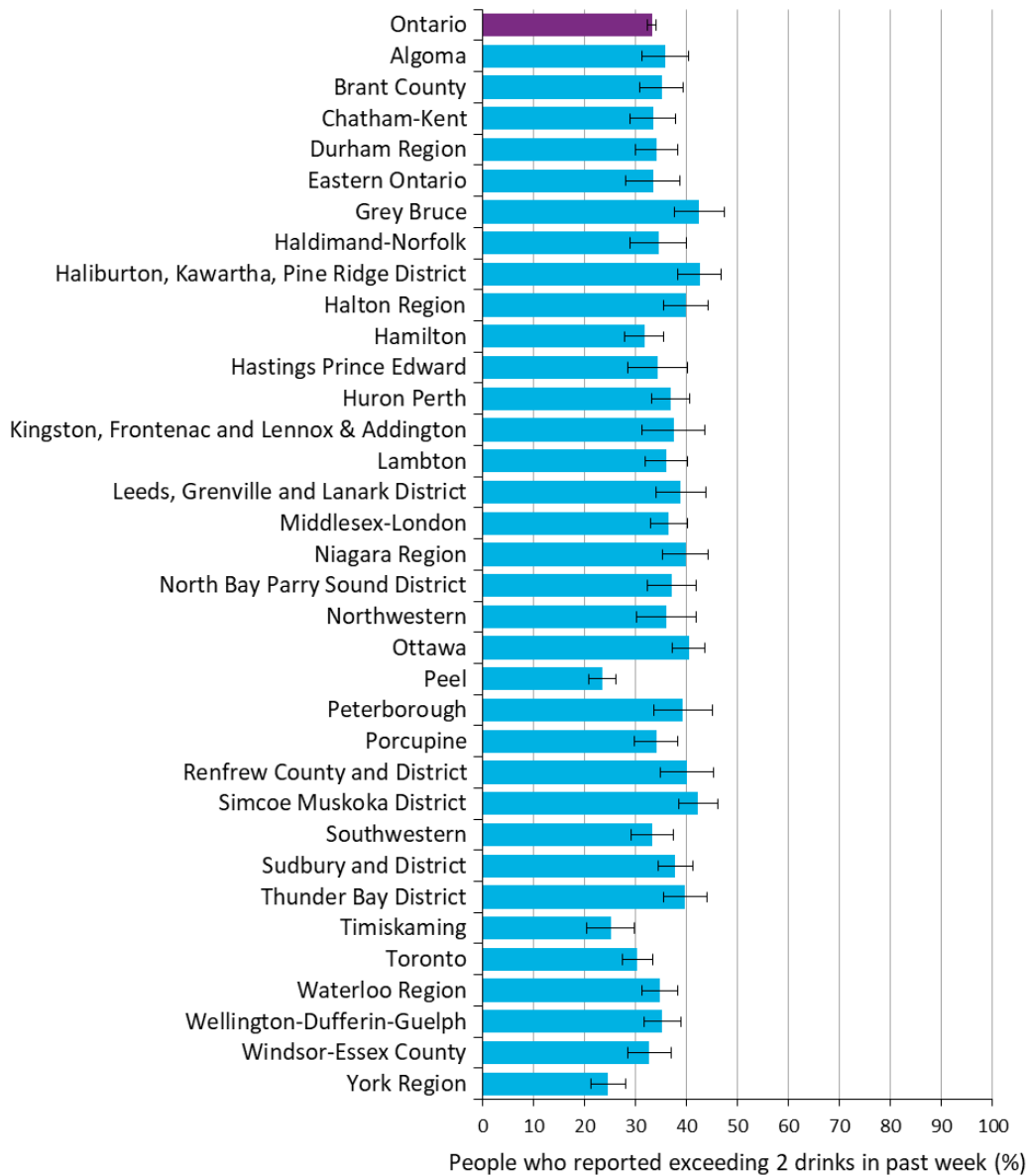
Figure 3: Percentage of people age 15 and older who reported binge drinking, by public health unit, Ontario, 2015–2017 combined



Data sources: Canadian Community Health Survey, 2015/2016 cycle combined with 2017 annual component (Statistics Canada)

Data notes: |—| represents 95 per cent confidence intervals. Heavy alcohol consumption (age 15 and older) = respondents who reported binge drinking (five drinks for males and four drinks for females on one occasion, at least once a month in the past 12 months). Data are presented in Supplementary Table S2. Download supplementary tables at ontariohealth.ca/smoking-alcohol.

Figure 4: Percentage of people age 19 and older who reported exceeding two drinks in the past week, by public health unit, Ontario, 2015–2017 combined



Data sources: Canadian Community Health Survey, 2015/2016 cycle combined with 2017 annual component (Statistics Canada)

Data notes: |—| represents 95 per cent confidence intervals. Risky alcohol consumption (age 19 and older) = respondents who exceed two drinks in the past week. Data are presented in Supplementary Table S2. Download supplementary tables at ontariohealth.ca/smoking-alcohol.

Results: Attributable harms in Ontario

This section presents smoking and alcohol attributable mortality, hospitalizations and emergency department visits in Ontario. The attributable burden estimates by public health unit are available at ontariohealth.ca/smoking-alcohol.

Smoking

Table 4: Estimates of average annual deaths, hospitalizations and emergency department visits from health conditions attributable to smoking in people age 35 and older, Ontario

	Total smoking attributable health conditions	Cancer	Cardiovascular diseases	Diabetes	Respiratory diseases
Deaths	16,673	7,583	5,122	158	3,809
Hospitalizations	68,046	8,469	30,811	661	28,105
Emergency department visits	125,384	3,718	33,395	1,384	86,887

Data sources: Smoking prevalence from Canadian Community Health Survey cycles 2015 to 2017 (Statistics Canada). Deaths from Vital Statistics – Death, 2014 to 2018, Office of the Registrar General. Hospitalizations from Discharge Abstract Database 2015 to 2019, Ontario Ministry of Health, IntelliHEALTH ONTARIO, Extracted November 2021. Emergency department visits from National Ambulatory Care Reporting System 2015 to 2019, Ontario Ministry of Health, IntelliHEALTH ONTARIO, Extracted November 2021.

Data notes: The most recent five years of data available were used to calculate the average annual total number of deaths, hospitalizations and emergency department visits for each health outcome. Cause of death based on primary cause. Hospitalizations based on main diagnosis code. Emergency department visits based on primary diagnosis. Due to rounding, the total count may differ slightly from the sum of all the individual categories. Smoking population attributable fractions and data presented by sex are in the supplementary tables. Download supplementary tables at ontariohealth.ca/smoking-alcohol.

In an average year, an estimated 16,673 deaths, 68,046 hospitalizations and 125,384 emergency department visits in Ontario were attributable to smoking in people age 35 and older. These made up 17.0 per cent of deaths, 8.7 per cent of hospitalizations and 3.4 per cent of emergency department visits from all causes in people age 35 and older in Ontario. Smoking attributable deaths, hospitalizations and emergency department visits were more common in males than females in each disease category (see Supplementary Table S3).

Alcohol

Table 5: Estimates of average annual deaths, hospitalizations and emergency department visits from health conditions attributable to alcohol in people age 15 and older, Ontario

	Total alcohol attributable health conditions	Cancer	Cardiovascular diseases	Communicable diseases	Digestive conditions	Endocrine conditions	Neuro-psychiatric conditions	Intentional injuries	Motor vehicle collisions	Unintentional injuries
Deaths	4,330	1,204	934	126	865	-67	329	306	87	545
Hospitalizations	22,009	2,071	-2,263	1,282	4,709	-285	8,379	1,250	672	6,194
Emergency department visits	194,692	613	2,528	5,559	5,435	-927	57,536	9,112	9,391	105,446

Data sources: Alcohol consumption from Canadian Community Health Survey cycles 2015 to 2017 (Statistics Canada), Statistics Canada’s alcohol sales data (2014 to 2020) and World Health Organization data on tourist and unrecorded consumption (2019). Deaths from Vital Statistics – Death, 2014 to 2018, Office of the Registrar General. Hospitalizations from Discharge Abstract Database 2015 to 2019, Ontario Ministry of Health, IntelliHEALTH ONTARIO, Extracted November 2021 and Ontario Mental Health Reporting System 2014 to 2018, Ontario Ministry of Health, IntelliHEALTH ONTARIO, Extracted November 2021. Emergency department visits from National Ambulatory Care Reporting System 2015 to 2019, Ontario Ministry of Health, IntelliHEALTH ONTARIO, Extracted November 2021.

Data notes: The most recent five years of data available were used to calculate the average annual total number of deaths, hospitalizations and emergency department visits for each health outcome. Cause of death based on primary cause. Hospitalizations for all non-injury diagnoses based on main diagnosis code. Hospitalizations for injury diagnoses based on prioritization scheme outlined in technical appendix. Emergency department visits for all non-injury diagnoses based on primary diagnosis. Emergency department visits for injury diagnoses based on prioritization scheme outlined in technical appendix. Due to rounding, the total count may differ slightly from the sum of all the individual categories. Negative numbers indicate protective effects and therefore represent the estimated number of deaths or hospitalizations or emergency department visits that were prevented in an average year over the five-year timespan shown. Alcohol population attributable fractions and data presented by sex are in the supplementary tables. Download supplementary tables at ontariohealth.ca/smoking-alcohol.

In an average year, an estimated 4,330 deaths, 22,009 hospitalizations and 194,693 emergency department visits in Ontario were attributable to alcohol in people age 15 and older. These made up 4.3 per cent of deaths, 2.1 per cent of hospitalizations and 3.7 per cent of emergency department visits from all causes in people age 15 and older in Ontario. Alcohol attributable deaths, hospitalizations and emergency department visits were more common in males than females in each category (see Supplementary Table S4).

Discussion

This report highlights the substantial burden of disease caused by smoking and alcohol consumption in Ontario overall and by public health unit. In an average year, 16,673 deaths (data from 2014 to 2018), 68,046 hospitalizations (data from 2015 to 2019) and 125,384 emergency department visits (data from 2015 to 2019) were attributable to smoking. These smoking attributable outcomes made up 17.0 per cent of deaths, 8.7 per cent of hospitalizations and 3.4 per cent of emergency department visits from all causes in Ontario. During the same study period, 4,330 deaths, 22,009 hospitalizations and 194,693 emergency department visits were attributable to alcohol. These alcohol attributable outcomes made up 4.3 per cent of deaths, 2.1 per cent of hospitalizations and 3.7 per cent of emergency department visits from all causes in Ontario.

This report also identifies the health conditions that contribute the largest number of harms attributable to smoking and alcohol. In Ontario, the majority of smoking attributable deaths were from cancer and cardiovascular conditions. The largest number of smoking attributable hospitalizations were from cardiovascular diseases and respiratory conditions. Smoking attributable emergency department visits were highest for respiratory conditions, followed by cardiovascular diseases. Different patterns were observed for alcohol attributable conditions. For example, the majority of hospitalizations from alcohol attributable health conditions were for neuropsychiatric conditions, such as alcoholic psychosis, intoxication, withdrawal, amnesic syndrome, and other mental and behavioural conditions, followed by unintentional injuries. Similarly, the majority of emergency department visits for alcohol attributable health conditions were for unintentional injuries followed by neuropsychiatric conditions. The largest number of alcohol attributable deaths were from cancer or cardiovascular diseases. These results can be used to not only inform preventive measures, but also anticipate how many people will experience certain health outcomes and help plan treatment options for these outcomes.

The results in this report also highlight considerable variation between public health units in terms of the prevalence of smoking and alcohol consumption and their attributable harms. Although the pattern for alcohol attributable harms was similar across most public health units, the pattern for smoking attributable harms varied more (see appendix A at ontariohealth.ca/smoking-alcohol for public health unit-specific smoking and alcohol population attributable fractions). It is likely that this variation is due to different consumption patterns between public health units and different demographic characteristics that may predispose people to these diseases, such as the age and sex composition of each region and other environmental exposures. These results provide an opportunity for individual public health units to tailor tobacco control and alcohol harm reduction strategies to their local contexts.

A major strength of this report's analysis is that deaths, hospitalizations and emergency department visits were pulled from health administrative data with comprehensive coverage of Ontario's population. Health conditions that are entirely attributable to smoking and alcohol, and conditions that are partially attributable

to smoking and alcohol were included in the analysis of this report, which increases the robustness of the estimates.

A number of considerations should be taken into account when interpreting the findings of this report. The prevalence estimates for smoking and alcohol consumption used to calculate the population attributable fractions were provincial rather than public health unit-specific. This was due to small sample sizes and unreliable estimates at the public health unit level, which were a result of the finely cut data by sex and age group needed for the population attributable fraction calculations. In addition, smoking and alcohol consumption were self-reported and therefore prone to biases associated with self-report, such as recall bias and social desirability bias. There is also the potential for measurement bias because people may transition from current smoking or drinking to former smoking or drinking, which would not be reflected in the estimates provided. The relative risks for mortality were used for all the outcomes (deaths, hospitalizations, emergency department visits) when outcome-specific relative risks were not available. For alcohol and smoking, there may be a lag between exposure and health outcomes, which was not accounted for in the analysis, given the inconsistency in lag time between different exposures and health outcomes. Finally, the methods used to calculate smoking and alcohol population attributable fractions were different and therefore the results are not directly comparable across the two behaviours.

The exclusion of secondary causes for deaths, hospitalizations and emergency department visits may have resulted in undercounting in certain health condition categories and overcounting in other categories. Deaths, hospitalizations and emergency department visits often have multiple causes or diagnoses, so to avoid double counting and because secondary causes are less reliable, only primary cause of death or primary diagnosis was counted for each harm. As long as the primary cause was at least partially attributable to smoking or alcohol, the harm was included in the estimates of total harms. However, if the primary cause was not attributable to smoking or alcohol and a secondary cause was attributable, the harm was not included in the estimates for this report. For example, some hospital visits had knee osteoarthritis recorded as the primary diagnosis and diabetes recorded as a secondary diagnosis. These visits were not included in the estimates because osteoarthritis (the primary diagnosis) is not attributable to alcohol, even though diabetes is partially attributable. Among excluded secondary diagnoses, over 98 per cent of the conditions were partially attributable to alcohol and less than two per cent of the conditions were fully attributable to alcohol. Therefore, some harms associated with secondary diagnoses that may be attributable to alcohol or smoking were excluded.

An independent assessment of the methodological quality of the studies that informed the relative risk estimates used in the population attributable fractions was beyond the scope of this analysis. Moreover, the modelling has not been updated to account for changes in the emerging literature on cardio-protective effects. Although recent research has strongly contested the protective effects observed in the studies used for this report (38, 65, 66), the estimates used in the InterMAHP tool are based on relative risk estimates from meta-analyses, indicating a degree of protection associated with low-level alcohol consumption for specific health conditions, namely ischemic heart disease. In light of the research reported in more recent scientific literature, the alcohol attributable harms may be greater than the estimates provided in this report.

InterMAHP's relative risk estimates for ischemic heart disease came from two meta-analyses. One was from 2012 that showed some degree of protection against ischemic heart disease mortality and morbidity among men and women, although at much lower levels of drinking among women.(89) The other was from 2017 and showed protection against coronary heart disease mortality risk, but only among people older than 55, in lower quality studies and in studies that did not control for heart health.(37)

The list of smoking and alcohol attributable harms in this report is incomplete because certain outcomes, such as fetal alcohol spectrum disorder, have less readily available data. Harms that did not result in death, hospitalization or an emergency department visit were also not captured in the analysis, which relied on health system administrative data. Therefore, the overall number of harms attributable to smoking and alcohol is larger than the totals in this report. Additionally, due to limitations of the data available, the analysis was not able to incorporate socioeconomic differences that may impact the effect of smoking and alcohol on various harms. Likewise, because data were only available up to 2019 at the time of analysis, an examination of the impact of COVID-19 on smoking and alcohol attributable harms was not possible. When data become available, future research is warranted on the substantial impact of the COVID-19 pandemic on chronic disease prevention and health outcomes.

For more detailed information on the methodology and data considerations for this report, please refer to the technical appendix.

Local opportunities for prevention

The results from the analysis highlight the need for system-level policies and programs at federal, provincial and local levels to prevent and reduce smoking and alcohol consumption.

Reducing smoking

Comprehensive tobacco control policies and programs that target industry, prevention, protection and cessation can reduce smoking.(90) The Smoke-Free Ontario Scientific Advisory Committee identified the following tobacco control policies and programs (90) as part of a comprehensive strategy:

- Increased prices and taxation;
- Bans on tobacco advertising promotion and sponsorship;
- Bans on point of sale displays;
- Increased anti-contraband measures;
- Product and packaging restrictions;
- Availability restrictions;
- Frequent mass media health promotion campaigns of sufficient duration;
- Broadened protection from second-hand smoke exposures in outdoor settings, homes and workplaces; and
- Increased access to smoking cessation programs.

A comprehensive policy approach is needed at different levels of government to achieve effective tobacco control. While many of the policies listed above are enacted at the federal or provincial level, municipalities and public health units have worked together locally to implement a range of tobacco control policies and programs. Tobacco, cannabis and vaping by-laws have been implemented in numerous municipalities to prohibit the use of these substances in a variety of public spaces.(91) For example, Niagara Region has a smoke- and vape-free outdoor spaces by-law that prohibits the use of tobacco, cannabis and vaping products in many public places, such as beaches, recreation trails, parks and playgrounds.(92) The city of Orillia also has a by-law that prohibits smoking and vaping in many public places, such as docks, trails and parking lots.(93) Smoke-free policies can decrease smoking behaviours and protect people from harmful effects of second-hand smoke exposure.(94-96)

Many municipalities have implemented smoke-free policies in their community housing buildings and have encouraged policies in privately owned apartment and condominium buildings.(91, 97, 98) These policies ban the use of tobacco in private units and on balconies to reduce second-hand smoke exposure at home. People who live in community housing are more at risk because they are less able to select new housing if experiencing second-hand smoke.(99) Peel, Simcoe County, Thunder Bay District and Ottawa are examples of municipalities with smoke-free policies in their community housing corporations.(100)

Another policy intervention that a number of municipalities have implemented is the requirement for tobacco retailers to obtain a license to sell tobacco, and to pay for their license and annual renewal fees.(101) As of February 2018, these fees ranged from \$30 in Hearst to \$893 in Ottawa.(101) The implementation of licenses and fees may reduce the number of stores that sell tobacco and the overall availability of tobacco.(90, 101-103)

The availability and density of retail stores that sell tobacco are associated with high tobacco use and initiation, and reduced smoking cessation.(104, 105) Furthermore, youth have been shown to be more likely to smoke when their home has a high density of tobacco retail stores nearby, (105) highlighting the need to control tobacco retail density.

In addition to the above examples, comprehensive tobacco control policies and programs should include the prevention of vaping (including e-cigarette initiation), and mixing of tobacco and cannabis. Vaping among youth and young adults is associated with increased use of tobacco smoking (106), with some evidence showing that vaping increases the frequency and the number of cigarettes smoked by these populations.(106) Ontario has seen an increase in the use of vaping products, particularly among young adults and youth (107, 108), which may lead to future tobacco smoking. From 2015 to 2017, 31 per cent of adults in Ontario who used cannabis reported mixing it with tobacco in the past year.(109) The practice of mixing tobacco and cannabis may increase the number of people smoking tobacco who otherwise would not have.(109)

For a detailed list of local policies and programs that can support the reduction in tobacco use, visit the 2018 [Ontario Tobacco Monitoring Report](#) and Public Health Ontario's [tobacco, vaping and cannabis by-law summary](#). For an overview of provincial policies and programs, visit Ontario Health's [Prevention System Quality Index](#).

Reducing alcohol use

Comprehensive alcohol strategies are also recommended for reducing alcohol consumption, and acute and chronic alcohol-related harms.(110-112) The Canadian Alcohol Policy Evaluation project assessed evidence-based policies aimed at reducing alcohol consumption and recommended the following policy actions (111):

- Increased prices and taxation;
- Restrictions on marketing and advertising;
- Physical availability restrictions;
- Strong impaired driving counter measures;
- Minimum legal drinking age and graduated drinking policies;
- Increased screening, brief interventions and referrals to treatment;
- Enhanced liquor law enforcement programs;
- An alcohol control system;
- A provincial alcohol strategy;
- Regular monitoring and reporting on consumption and alcohol-related harms; and
- Health and safety messaging on labels, at on- and off-premise outlets, and on other media platforms.

Similar to tobacco, many alcohol policies are implemented at federal and provincial levels of government; however, there are opportunities for local policy action. Municipal alcohol policies and municipal by-laws can help manage alcohol availability, which is important because physical availability of alcohol is linked to increased alcohol consumption.(113, 114)

Municipal alcohol policies are a tool that can help manage alcohol consumption in the community. Municipal alcohol policies are developed in accordance with provincial alcohol policies and identify how, where and how much alcohol can be served on municipal property. These policies can provide guidance on how alcohol can be advertised at events.(115)

Municipal by-laws are another way to control alcohol at a local level. For example, the city of Barrie has implemented a zoning by-law for night clubs that helps reduce the density of on-site consumption venues. This by-law requires a minimum distance of 200 metres between nightclubs and 200 metres from residential zones. The city of Vaughan has implemented a business license by-law to restrict liquor licenses to businesses that are an eating establishment, which reduces the types of establishments that can apply for a license.(116)

For more information on local alcohol policies that can support the reduction of alcohol use, visit [Alcohol policy review: opportunities for Ontario municipalities](#) commissioned by the Wellington-Dufferin Guelph, Thunder Bay District and Durham Region health units.

For more information on provincial and federal alcohol policies, visit:

- Ontario Health's [Prevention System Quality Index](#);
- The [Canadian Alcohol Policy Evaluation Project](#); and
- The Centre for Addiction and Mental Health's [Alcohol Policy Framework](#).

Conclusion

This report, produced jointly by Ontario Health and Public Health Ontario, provides estimates on the prevalence of smoking and alcohol consumption, as well as smoking and alcohol attributable mortality, hospitalizations and emergency department visits by public health unit and across Ontario. The overall burden of disease caused by smoking and alcohol use is considerable. Reducing smoking and alcohol use in Ontario has the potential to decrease the substantial burden of disease caused by these two substances.

This report provides public health units and other partners with the regional data and policy considerations needed to develop and support comprehensive strategies for reducing per capita alcohol consumption and smoking in Ontario. This report builds on the 2019 [Burden of Chronic Diseases in Ontario](#) report, which provided estimates of the burden of chronic diseases related to four major risk factors in Ontario.

Ontario Health and Public Health Ontario continue to work with partners to support chronic disease prevention and management to reduce the burden of chronic diseases through [Ontario Health's Chronic Disease Prevention Strategy 2020 to 2023](#) and [Public Health Ontario's Strategic Plan, 2020–2023](#). More information about Ontario Health's and Public Health Ontario's work in chronic disease prevention can be found on their websites.

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