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The Burden of Chronic Diseases in Ontario

Key Estimates to Support Efforts in Prevention

July 2019

Technical Appendix

The report and associated supplemental materials are available at ccohealth.ca/cdburden and publichealthontario.ca/cdburden.

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DATA SOURCES

For more detailed information on all data sources, please see the [Health Analyst's Toolkit](#) from the Ontario Ministry of Health and Long-Term Care.

Vital statistics (IntelliHEALTH ONTARIO)

DESCRIPTION

Vital statistics data include mortality data on all Ontario residents who died in the province. Data are provided by Statistics Canada and the Office of the Registrar General, Service Ontario and distributed by the Ontario Ministry of Health and Long-Term Care through IntelliHEALTH ONTARIO, a repository that contains clinical and administrative data collected from various sectors of the Ontario healthcare system.

DATA AVAILABILITY AND LIMITATIONS

The most recent year for which mortality data are available in IntelliHEALTH ONTARIO is 2015.

Data on deaths are virtually complete, but underreporting can occur for deaths of unidentified people and of Ontarians who die outside of the province. Vital statistics data include only the underlying cause of death, not antecedent causes or other significant contributors.

Canadian Chronic Disease Surveillance System

Ontario incidence and prevalence estimates for cardiovascular diseases, chronic lower respiratory diseases, and diabetes were obtained directly from the Canadian Chronic Disease Surveillance System (CCDSS). CCDSS is available from the Public Health Agency of Canada's (PHAC) [Public Health Infobase](#).

DESCRIPTION

CCDSS is a collaborative network of provincial and territorial surveillance systems supported by PHAC. In each province and territory, the health insurance registry database is linked to the physician billing and hospitalization databases using the health card number as a unique personal identifier. Where available and specified by the case definition, data from prescription drug databases are also linked.

Case definitions are applied to these linked databases to identify individuals with chronic diseases and aggregate data are sent to PHAC. The aggregate data are used by PHAC to estimate the incidence, prevalence, all-cause mortality, use of health services (e.g., hospitalizations and physician visits), and comorbidities on a national level.

DATA AVAILABILITY

The most recent year for which OCR data are available is 2015.

Ontario Cancer Registry

Ontario cancer incidence data were obtained from the Ontario Cancer Registry (OCR).

DESCRIPTION

The OCR is a computerized database containing information on all Ontario residents who have been newly diagnosed with invasive neoplasia (except for basal cell and squamous cell skin cancers). Electronic records are linked at the person level and then “resolved” into incident cases of cancer using computerized medical logic. Major data sources of the OCR include the following:

- Cancer-related hospital discharge and day surgery reports from the Canadian Institute for Health Information (CIHI);
- Cancer-related pathology reports, received mostly electronically from hospital and community laboratories;
- Consultation and treatment records of patients referred to one of 14 Regional Cancer Centres; and
- Death certificates with cancer identified as the underlying cause of death, received from the Ontario Registrar General.

DATA AVAILABILITY

The most recent year for which OCR data is available was 2015.

Discharge Abstract Database

DESCRIPTION

The [Discharge Abstract Database](#) (DAD) contains administrative, clinical, and demographic data for all inpatient acute care hospital discharges in Canada. Ontario data are provided by CIHI and distributed by the Ontario Ministry of Health and Long-Term Care through IntelliHEALTH. Data for the current report were extracted from the Inpatient Discharges database in IntelliHEALTH.

DATA AVAILABILITY AND LIMITATIONS

The most recent calendar year for which inpatient discharge data are available is 2017. However, this report uses data from the 2016 calendar year to allow rate reporting. Rate reporting requires population estimates, and the most recent population estimates available are for 2016.

Hospitalization data coverage is high, as assessed annually by CIHI. Data quality control and special studies are also performed by CIHI, see the [Data Quality Documentation, Discharge Abstract Database—Multi-Year Information report](#).

Canadian Community Health Survey

DESCRIPTION

The Canadian Community Health Survey (CCHS) is a population-based, cross-sectional survey conducted by Statistics Canada. It collects information regarding health status, health care utilization and determinants of health for the Canadian population.

DATA AVAILABILITY AND LIMITATIONS

The CCHS has been administered annually, where two years of data are considered one full cycle. The most recent cycle for which CCHS data are available is 2015/2016.

The CCHS is representative of approximately 97% of the Canadian population ages 12+, but excludes individuals living on Indian Reserves and on Crown Lands, institutional residents, fulltime members of the Canadian Forces, and residents of certain remote regions.

Ontarians who do not have a phone number (home or mobile) are excluded from the CCHS, which underestimates risk factor prevalence in some of the most vulnerable populations, including those who are homeless.

Ontario Marginalization Index

DESCRIPTION

Ontario Marginalization Index (ON-Marg) is a data tool that combines demographic indicators into dimensions of marginalization. In this report we use the dimension of material deprivation as a proxy for socioeconomic status. Details are provided below in the [General Analytic Notes](#) section (page 7).

The 2016 version of ON-Marg was created by Public Health Ontario (PHO) and the Centre for Urban Health Solutions at St. Michael's Hospital, using data retrieved from the 2016 Canadian census.

Citation: Matheson FI; Ontario Agency for Health Protection and Promotion (Public Health Ontario). 2016 Ontario marginalization index: user guide. Toronto, ON: Providence St. Joseph's and St. Michael's Healthcare; 2018. Joint publication with Public Health Ontario.

DATA AVAILABILITY AND LIMITATIONS

The most recent year for which ON-Marg is available is 2016. ON-Marg is freely-available on [PHO's website](#).

There are missing data in the dissemination area (DA) files due to data suppression (e.g., income). Additionally, in some areas, input variables have a value of zero. For example, a DA may not have any recent immigrants. Limitations of census coverage also limit ON-Marg sensitivity. Some populations, for example Indigenous people living on reserves, may be under-counted in the census. ON-Marg may not be as sensitive for these populations. Additionally, institutionalized populations, such as those living in nursing homes or penitentiaries, are not counted in the long-form census and so are not included in the Index (see [the ON-Marg User Guide](#)).

GENERAL ANALYTIC NOTES

Socioeconomic status

This report uses material deprivation quintiles from ON-Marg as a proxy for socioeconomic status. There were two main reasons for doing so:

1. Mortality and hospitalization records do not include data on individual-level socioeconomic status. In these cases, a DA-level quintile for material deprivation was assigned to each individual based on the DA in which they resided, as a proxy for individual-level socioeconomic status. For consistency, ON-Marg material deprivation quintiles were also used with risk factor prevalence data from CCHS.
2. The ON-Marg dimension material deprivation has the advantage of combining several important indicators into a single measure (see below).

Material deprivation is closely connected to poverty and it refers to individual and community inability to access and attain basic material needs. The full list of indicators included in the dimension of material deprivation includes:

- Proportion of the population ages 20+ without a high-school diploma;
- Proportion of families who are lone parent families;
- Proportion of total income from government transfer payments for population ages 15+;
- Proportion of the population ages 15+ who are unemployed;
- Proportion of the population considered low-income (based on the Low-Income Cut-Off);
- Proportion of households living in dwellings that are in need of major repair.

For more details on ON-Marg, please see the [ON-Marg User Guide](#).

Health equity analyses

MORTALITY AND HOSPITALIZATION DATA

- For hospitalization and death records in IntelliHEALTH, individuals were assigned to a quintile of marginalization based on the material deprivation measure from ON-Marg 2016:
 - The Postal Code Conversion File Plus (PCCF+) Version 6C was used to assign individuals to a DA based on their postal code,
 - Individuals were then linked to a DA-level quintile of marginalization.

- Rates were calculated using DA-level population estimates in ON-Marg 2016;
- 95% confidence intervals for rates were calculated using a Poisson approximation of the binomial distribution;
- Records were excluded when: they were missing a valid Ontario postal code, or they were linked to a DA without measures of deprivation in ON-Marg 2016 (e.g. where data suppression occurred).
- Summary measures of inequality were run to determine if material deprivation was significantly associated with the rate of hospitalization or death, specifically, to determine whether Ontarians living in more deprived neighbourhoods were more likely to be hospitalized for, or die from, the disease of interest compared to Ontarians in less deprived neighbourhoods. The summary measures used are:
 - Slope Index of Inequality (SII) is an absolute measure of inequality between the most deprived and least deprived. Inequality exists when the SII estimate is negative and the confidence interval does not include 0.
 - Relative Index of Inequality (RII) mean is a relative measure of inequality between the most deprived and the least deprived. Inequality exists when the RII mean is negative and the confidence interval does not include 0.

CCHS PREVALENCE DATA

- For self-reported disease prevalence and health behaviours prevalence in CCHS 2015-2016, individuals were assigned to a quintile of marginalization based on the Material Deprivation measure from ON-Marg 2016:
 - The CCHS 2015-2016 share file included a variable with 2011 dissemination area (DA);
 - Individuals were linked to a DA-level quintile of marginalization only when living in a DA that did not change between 2011 and 2016, resulting in the exclusion of 3% (weighted) of CCHS respondents from this component of the analysis.
- PROC SURVEYFREQ and PROC SURVEYMEANS procedures in SAS (SAS Enterprise Guide 7.1) were used to calculate 95% confidence intervals with bootstrapping (1000 replicates).
- Records were excluded when: they lived in DA that changed between 2011 and 2016, or they were linked to a DA without measures of deprivation in ON-Marg 2016 (e.g. where data suppression occurred).
- Rao-Scott Chi-Square tests were performed to determine the association between the two categories (e.g. chronic disease prevalence and material deprivation quintiles). Inequality exists when there is an association between the outcome or risk factor and material deprivation quintile or mental health status.
- Linear regression (PROC SURVEYREG) was used to determine the association between recreational screen time (continuous variable) and level of deprivation.

MORTALITY INDICATORS

All causes of death

DEFINITION

Each death in Ontario in 2015 was classified into one of the following categories:

- Cancer
- Cardiovascular disease
- Chronic lower respiratory disease
- Diabetes
- Other chronic diseases
- Injuries
- Influenza / respiratory infections
- Neuropsychiatric conditions
- All others

Classifications followed the [World Health Organization's report Global Burden of Disease in 2002: data sources, methods and results](#).

Category	ICD10 Codes
Cancer	--
Malignant neoplasms (e.g. colon cancer, breast cancer)	C00-C97
Other neoplasms	D00-D48
Cardiovascular disease	--
Cardiovascular disease (e.g. hypertensive heart disease, ischaemic heart disease)	I00-I99
Chronic lower respiratory diseases	--
Lower respiratory diseases (e.g. chronic obstructive pulmonary disease, asthma)	J40-J47
Diabetes	--
Diabetes mellitus	E10-E14
Other chronic diseases	--
Endocrine disorders	D55-D64 (excluding D64.9), D65-D89, E03-E07, E15-E16, E20-E34, E65-E88

Category	ICD10 Codes
Sense organ diseases (e.g. glaucoma, cataracts)	H00-H61, H68-H93
Other respiratory diseases	J30-J39, J48-J98
Digestive diseases (e.g. peptic ulcer disease, cirrhosis of the liver)	K20-K92
Genito-urinary diseases (e.g. nephritis)	N00-N64, N75-N98
Skin diseases	L00-L98
Musculoskeletal diseases (e.g., arthritis, gout)	M00-M99
Congenital abnormalities (e.g., abdominal wall defect, cleft palate, Down syndrome)	Q00-Q99
Oral conditions (e.g. dental caries, periodontal disease)	K00-K14
Influenza/respiratory infections	--
Lower respiratory infections	J10-J18, J20-J22
Upper respiratory infections	J00-J06
Otitis media	H65-H66
Injuries	--
Unintentional injuries (road traffic accidents, poisonings, falls, fires, drownings, other unintentional injuries)	V01-X59, Y40-Y86, Y88, Y89
Intentional injuries (self-inflicted injuries, violence, war, other intentional injuries)	X60-Y09, Y35-Y36, Y870, Y871
Injury with undetermined intent	Y10-Y34, Y872
Neuropsychiatric conditions	--
Unipolar depressive disorders	F32-F33
Bipolar depressive disorders	F30-F31
Schizophrenia	F20-F29
Epilepsy	G40-G41
Alcohol use disorders	F10
Alzheimer and other dementias	F01, F03, G30-G31
Parkinson disease	G20-G21
Multiple sclerosis	G35
Drug use disorders	F11-F16, F18-F19
Post-traumatic stress disorder	F43.1
Obsessive compulsive disorder	F42

Category	ICD10 Codes
Panic disorder	F40.0, F41.0
Insomnia (primary)	F51
Migraine	G43
Mental retardation attributed to lead exposure	F70-F79
Other neuropsychiatric disorders	F04-F09, F17, F34-F39, F401- F409, F411-F419, F43 (excluding F43.1), F44-F50, F52-F69, F80-F99, G06-G12, G23-G25, G36, G37, G44- G98
All other	--
Infectious and parasitic disease	
• Tuberculosis	A15-A19, B90
• Sexually transmitted diseases excluding HIV	A50-A64, N70-N73
• HIV/AIDS	B20-B24
• Diarrhoeal diseases	A00, A01, A03, A04, A06-A09
• Childhood-cluster diseases (pertussis, poliomyelitis, diphtheria, measles, tetanus)	A33-A37, A80, B05, B91
• Meningitis	A39, G00, G03
• Hepatitis B and Hepatitis C	B16-B19
• Malaria	B50-B54
• Tropical-cluster diseases (e.g., trypanosomiasis)	B55-B57, B65, B73, B74.0-B74.2
• Leprosy	A30
• Dengue	A90-A91
• Japanese encephalitis	A83.0
• Trachoma	A71
• Intestinal nematode infections	B76-B81
Maternal conditions	
• Maternal haemorrhage	O44-O46, O67, O72
• Maternal sepsis	O85-O86
• Hypertensive disorders of pregnancy	O10-O16

Category	ICD10 Codes
<ul style="list-style-type: none"> • Obstructed labour • Abortion • Other maternal conditions 	O64-O66 O00-O07 O20-O43, O47-O63, O68-O71, O73-O75, O87-O99
Conditions arising during the perinatal period	--
<ul style="list-style-type: none"> • Low birth weight • Birth asphyxia and birth trauma • Other perinatal conditions 	P05-P07 P03, P10-P15, P20-P29 P00-P02, P04, P08, P35-P96
Nutritional deficiencies	--
<ul style="list-style-type: none"> • Protein-energy malnutrition • Iodine deficiency • Vitamin A deficiency • Iron-deficiency anemia • Other nutritional deficiencies 	E40-E46 E00-E02 E50 D50, D64.9 D51-D53, E51-E64
Symptoms, signs and abnormal clinical and laboratory findings not elsewhere classified	--
<ul style="list-style-type: none"> • Ill-defined and unknown causes of mortality • Other not otherwise classified and causes with unknown diagnoses 	R95-R99 R00-R94
Influenza due to certain identified viruses (e.g., avian influenza virus, swine flu)	J09

CALCULATION

Percentages were calculated for each category by dividing the number of deaths in the category by the total number of deaths. For example, for cancer:

$$\left(\frac{\text{Number of deaths due to cancer in Ontario in 2015}}{\text{Number of deaths in Ontario in 2015}} \right) \times 100$$

EXCLUSIONS

Non-Ontario residents

DATA SOURCES

Death (Vital Statistics - Death), Ontario Ministry of Health and Long-Term Care, IntelliHEALTH ONTARIO, Extracted March 5, 2019.

Cancer mortality, number of deaths

DEFINITION

Number of deaths due to cancer in Ontario in 2015.

Cancer deaths identified by ICD-10 codes C00-C97.

Indicator aligns with the Association of Public Health Epidemiologists in Ontario (APHEO) [Cancer Mortality Core Indicator](#) and the PHO [Cancer Mortality Snapshot](#).

EXCLUSIONS

Non-Ontario residents

DATA SOURCES

Death (Vital Statistics - Death), Ontario Ministry of Health and Long-Term Care, IntelliHEALTH ONTARIO, Extracted March 5, 2019.

Cancer mortality, crude rate by material deprivation

DEFINITION

Crude rate of death from cancer per 100,000 population, stratified by ON-Marg material deprivation quintile.

Cancer deaths identified by ICD-10 codes C00-C97, aligning with the APHEO [Cancer Mortality Core Indicator](#) and the PHO [Cancer Mortality Snapshot](#).

CALCULATION

Rates were calculated for each quintile of material deprivation, by dividing the number of deaths within the quintile by the population of the quintile. For example, for quintile 1:

$$\left(\frac{\text{Number of cancer deaths in quintile 1}}{\text{Population in quintile 1}} \right) \times 100,000$$

95% confidence intervals were calculated using a Poisson approximation of the binomial distribution.

EXCLUSIONS

- Non-Ontario residents
- Cases with invalid or missing postal code
- Dissemination areas with missing data (i.e., no assigned quintile)

ANALYSIS

Significant inequalities in rates of death were determined by the summary measures of inequality SII and RII mean, as described above in the section on [Health Equity Analyses](#).

DATA SOURCES

Death (Vital Statistics - Death), Ontario Ministry of Health and Long-Term Care, IntelliHEALTH ONTARIO, Extracted March 5, 2019.

Matheson, FI; Ontario Agency for Health Protection and Promotion (Public Health Ontario). 2016 Ontario marginalization index: user guide. Toronto, ON: Providence St. Joseph's and St. Michael's Healthcare; 2018. Joint publication with Public Health Ontario.

Cardiovascular disease mortality, number of deaths

DEFINITION

Number of deaths due to cardiovascular disease in Ontario in 2015.

Cardiovascular disease deaths identified by ICD-10 codes I00-I99.

Indicator aligns with the APHEO [Chronic Disease Mortality Core Indicator](#) and the PHO [Chronic Disease Mortality Snapshot](#).

EXCLUSIONS

Non-Ontario residents

DATA SOURCES

Death (Vital Statistics - Death), Ontario Ministry of Health and Long-Term Care, IntelliHEALTH ONTARIO, Extracted March 5, 2019.

Cardiovascular disease mortality, crude rate by material deprivation

DEFINITION

Crude rate of death from cardiovascular disease per 100,000 population, stratified by ON-Marg material deprivation quintile.

Cardiovascular disease deaths identified by ICD-10 codes I00-I99, aligning with the APHEO [Chronic Disease Mortality Core Indicator](#) and the PHO [Chronic Disease Mortality Snapshot](#).

CALCULATION

Rates were calculated for each quintile of material deprivation, by dividing the number of deaths within the quintile by the population of the quintile. For example, for quintile 1:

$$\left(\frac{\text{Number of cardiovascular disease deaths in quintile 1}}{\text{Population in quintile 1}} \right) \times 100,000$$

95% confidence intervals were calculated using a Poisson approximation of the binomial distribution.

EXCLUSIONS

- Non-Ontario residents
- Cases with invalid or missing postal code
- Dissemination areas with missing data (i.e., no assigned quintile)

ANALYSIS

Significant inequalities in rates of death were determined by the summary measures of inequality SII and RII mean, as described above in the section on [Health Equity Analyses](#).

DATA SOURCES

Death (Vital Statistics - Death), Ontario Ministry of Health and Long-Term Care, IntelliHEALTH ONTARIO, Extracted March 5, 2019.

Matheson, FI; Ontario Agency for Health Protection and Promotion (Public Health Ontario). 2016 Ontario marginalization index: user guide. Toronto, ON: Providence St. Joseph's and St. Michael's Healthcare; 2018. Joint publication with Public Health Ontario.

Chronic lower respiratory disease mortality, number of deaths

DEFINITION

Number of deaths due to chronic lower respiratory disease in Ontario in 2015.

Chronic lower respiratory disease deaths identified by ICD-10 codes J40-J47.

Indicator aligns with the APHEO [Chronic Disease Mortality Core Indicator](#) and the PHO [Chronic Disease Mortality Snapshot](#).

EXCLUSIONS

Non-Ontario residents

DATA SOURCES

Death (Vital Statistics - Death), Ontario Ministry of Health and Long-Term Care, IntelliHEALTH ONTARIO, Extracted March 5, 2019.

Chronic lower respiratory disease mortality, crude rate by material deprivation

DEFINITION

Crude rate of death from chronic lower respiratory disease per 100,000 population, stratified by ON-Marg material deprivation quintile.

Chronic lower respiratory disease deaths identified by ICD-10 codes J40-J47, aligning with the APHEO [Chronic Disease Mortality Core Indicator](#) and the PHO [Chronic Disease Mortality Snapshot](#).

CALCULATION

Rates were calculated for each quintile of material deprivation, by dividing the number of deaths within the quintile by the population of the quintile. For example, for quintile 1:

$$\left(\frac{\text{Number of chronic lower respiratory disease deaths in quintile 1}}{\text{Population in quintile 1}} \right) \times 100,000$$

95% confidence intervals were calculated using a Poisson approximation of the binomial distribution.

EXCLUSIONS

- Non-Ontario residents
- Cases with invalid or missing postal code
- Dissemination areas with missing data (i.e., no assigned quintile)

ANALYSIS

Significant inequalities in rates of death were determined by the summary measures of inequality SII and RII mean, as described above in the section on [Health Equity Analyses](#).

DATA SOURCES

Death (Vital Statistics - Death), Ontario Ministry of Health and Long-Term Care, IntelliHEALTH ONTARIO, Extracted March 5, 2019.

Matheson, FI; Ontario Agency for Health Protection and Promotion (Public Health Ontario). 2016 Ontario marginalization index: user guide. Toronto, ON: Providence St. Joseph's and St. Michael's Healthcare; 2018. Joint publication with Public Health Ontario.

Diabetes mortality, number of deaths

DEFINITION

Number of deaths due to diabetes in Ontario in 2015.

Diabetes deaths identified by ICD-10 codes E10-E14.

Indicator aligns with the APHEO [Chronic Disease Mortality Core Indicator](#) and the PHO [Chronic Disease Mortality Snapshot](#).

EXCLUSIONS

Non-Ontario residents

DATA SOURCES

Death (Vital Statistics - Death), Ontario Ministry of Health and Long-Term Care, IntelliHEALTH ONTARIO, Extracted March 5, 2019.

Diabetes mortality, crude rate by material deprivation

DEFINITION

Crude rate of death from diabetes per 100,000 population, stratified by ON-Marg material deprivation quintile.

Diabetes deaths identified by ICD-10 codes E10-E14, aligning with the APHEO [Chronic Disease Mortality Core Indicator](#) and the PHO [Chronic Disease Mortality Snapshot](#).

CALCULATION

Rates were calculated for each quintile of material deprivation, by dividing the number of deaths within the quintile by the population of the quintile. For example, for quintile 1:

$$\left(\frac{\text{Number of diabetes deaths in quintile 1}}{\text{Population in quintile 1}} \right) \times 100,000$$

95% confidence intervals were calculated using a Poisson approximation of the binomial distribution.

EXCLUSIONS

- Non-Ontario residents
- Cases with invalid or missing postal code
- Dissemination areas with missing data (i.e., no assigned quintile)

ANALYSIS

Significant inequalities in rates of death were determined by the summary measures of inequality SII and RII mean, as described above in the section on [Health Equity Analyses](#).

DATA SOURCES

Death (Vital Statistics - Death), Ontario Ministry of Health and Long-Term Care, IntelliHEALTH ONTARIO, Extracted March 5, 2019.

Matheson, FI; Ontario Agency for Health Protection and Promotion (Public Health Ontario). 2016 Ontario marginalization index: user guide. Toronto, ON: Providence St. Joseph's and St. Michael's Healthcare; 2018. Joint publication with Public Health Ontario.

DISEASE INCIDENCE AND PREVALENCE INDICATORS

Cancer incidence and prevalence

DEFINITION

Cancer incidence is defined as new cases of cancer diagnosed and includes all cases of invasive neoplasia except for basal cell and squamous cell skin cancers.

Cancer prevalence is defined as the number of people diagnosed with cancer who are still alive.

DATA SOURCES

Ontario Cancer Registry, 2018 (Cancer Care Ontario)

Cardiovascular disease, chronic lower respiratory disease, and diabetes incidence and prevalence

DEFINITION

Crude incidence, age-standardized incidence and crude prevalence estimates were obtained directly from CCDSS for:

- Cardiovascular diseases: ischemic heart disease, acute myocardial infarction, stroke, heart failure, and hypertension
- Chronic lower respiratory diseases: chronic obstructive pulmonary disease (COPD) and asthma
- Diabetes

Disease case definitions and all analytic details can be found on [Public Health Agency of Canada's website](#).

DATA SOURCES

Public Health Agency of Canada. Canadian Chronic Disease Surveillance System [Internet]. Ottawa: Her Majesty the Queen in Right of Canada; 2017 [updated 2018 Dec 07; cited 2019 March 29].

Self-reported chronic disease prevalence, by material deprivation

DEFINITION

Self-reported prevalence of chronic disease, stratified by ON-Marg material deprivation quintile.

Estimates for the following disease were produced from CCHS for Ontarians ages 12+:

- Cancer
 - assigned when CCC_130 = 1 or CCC_135 = 1
- Cardiovascular diseases
 - Heart disease assigned when CCC_085 = 1
 - High blood pressure assigned when CCC_065 = 1
 - Suffering from the effects of a stroke assigned when CCC_090 = 1
- Chronic lower respiratory diseases
 - COPD assigned when CCC_030 = 1 (note: among Ontarians ages 35+)
 - Asthma assigned when CCC_015 = 1
- Diabetes
 - assigned when CCC_095 = 1

CALCULATION

Disease prevalence was stratified by quintile of material deprivation using PROC SURVEYFREQ. Prevalence of disease in each quintile was calculated by dividing the weighted number of respondents reporting the disease in the quintile by the weighted total number of respondents in the quintile. For example, the prevalence of diabetes within quintile 1 was calculated as follows:

$$\left(\frac{\text{Weighted number of respondents ages 12+ who report having diabetes in quintile 1}}{\text{Weighted total population ages 12+ in quintile 1}} \right) \times 100$$

95% confidence intervals were calculated using PROC SURVEYFREQ with bootstrapping (1000 replicates).

EXCLUSIONS

- Respondents in non-response categories (refusal, don't know, not stated) for required questions
- Dissemination areas with missing data (i.e., no assigned quintile)

ANALYSIS

Significant inequalities in prevalence of disease were determined by Rao-Scott Chi-Square tests, as described above in the section on [Health Equity Analyses](#).

DATA SOURCES

Canadian Community Health Survey, 2015/2016 cycle, Statistics Canada, Ontario Share File, Distributed by Ontario Ministry of Health and Long-Term Care.

Matheson, FI; Ontario Agency for Health Protection and Promotion (Public Health Ontario). 2016 Ontario marginalization index: user guide. Toronto, ON: Providence St. Joseph's and St. Michael's Healthcare; 2018. Joint publication with Public Health Ontario.

HOSPITALIZATION INDICATORS

Hospitalization data extraction

Data was extracted from the Inpatient Discharges database (IntelliHEALTH) using filters specified in the APHEO [Chronic Disease Hospitalization Core Indicator](#), specifically:

- Ontario patients only ([Patient Province] includes 'ONTARIO')
- Excludes newborns and stillbirths ([Admit Entry Type] excludes ('NEWBORN – BORN ALIVE IN REPORTING INSTITUTION', 'STILLBORN INFANT BORN IN REPORTING INSTITUTION')
- Includes acute care hospitals only ([Hospital Type] includes ('ACUTE CARE TREATMENT HOSP W/O PSYCH UNIT', 'ACUTE CARE TREATMENT HOSPITAL WITH PSYCH UNIT')

Cancer, number of hospitalizations

DEFINITION

Number of hospitalizations in Ontario in 2016 with a most-responsible diagnosis of cancer.

Cancer hospitalizations identified by ICD-10 codes C00-C97.

EXCLUSIONS

See [hospitalization data extraction](#).

DATA SOURCES

Inpatient Discharges (DAD), Ontario Ministry of Health and Long-Term Care, IntelliHEALTH ONTARIO, Extracted March 5, 2019.

Cancer, rate of hospitalizations by material deprivation

DEFINITION

Crude rate of hospitalizations in Ontario in 2016 with a most-responsible diagnosis of cancer (per 100,000 population), stratified by ON-Marg material deprivation quintile.

Cancer hospitalizations identified by ICD-10 codes C00-C97.

CALCULATION

Rates were calculated for each quintile of material deprivation, by dividing the number of cancer hospitalizations within the quintile by the population of the quintile. For example, for quintile 1:

$$\left(\frac{\text{Number of cancer hospitalizations in quintile 1}}{\text{Population in quintile 1}} \right) \times 100,000$$

95% confidence intervals were calculated using a Poisson approximation of the binomial distribution.

EXCLUSIONS

- See [hospitalization data extraction](#)
- Additional exclusions:
 - Cases with invalid or missing postal code
 - Dissemination areas with missing data (i.e., no assigned quintile)

ANALYSIS

Significant inequalities in rates of hospitalization were determined by the summary measures of inequality SII and RII mean, as described above in the section on [Health Equity Analyses](#).

DATA SOURCES

Inpatient Discharges (DAD), Ontario Ministry of Health and Long-Term Care, IntelliHEALTH ONTARIO, Extracted March 5, 2019.

Matheson, FI; Ontario Agency for Health Protection and Promotion (Public Health Ontario). 2016 Ontario marginalization index: user guide. Toronto, ON: Providence St. Joseph's and St. Michael's Healthcare; 2018. Joint publication with Public Health Ontario.

Cardiovascular diseases, number of hospitalizations

DEFINITION

Number of hospitalizations in Ontario in 2016 with a most-responsible diagnosis of cardiovascular disease.

Cardiovascular disease hospitalizations identified by ICD-10 codes I00-I99.

Indicator aligns with the APHEO [Chronic Disease Hospitalization Core Indicator](#) and the PHO [Chronic Disease Hospitalization Snapshot](#).

EXCLUSIONS

See [hospitalization data extraction](#).

DATA SOURCES

Inpatient Discharges (DAD), Ontario Ministry of Health and Long-Term Care, IntelliHEALTH ONTARIO, Extracted March 5, 2019.

Cardiovascular diseases, rate of hospitalizations by material deprivation

DEFINITION

Crude rate of hospitalizations in Ontario in 2016 with a most-responsible diagnosis of cardiovascular disease (per 100,000 population), stratified by ON-Marg material deprivation quintile.

Cardiovascular disease hospitalizations identified by ICD-10 codes I00-I99, aligning with the APHEO [Chronic Disease Hospitalization Core Indicator](#) and the PHO [Chronic Disease Hospitalization Snapshot](#).

CALCULATION

Rates were calculated for each quintile of material deprivation, by dividing the number of cardiovascular disease hospitalizations within the quintile by the population of the quintile. For example, for quintile 1:

$$\left(\frac{\text{Number of cardiovascular disease hospitalizations in quintile 1}}{\text{Population in quintile 1}} \right) \times 100,000$$

95% confidence intervals were calculated using a Poisson approximation of the binomial distribution.

EXCLUSIONS

- See [hospitalization data extraction](#)
- Additional exclusions:
 - Cases with invalid or missing postal code
 - Dissemination areas with missing data (i.e., no assigned quintile)

ANALYSIS

Significant inequalities in rates of death were determined by the summary measures of inequality SII and RII mean, as described above in the section on [Health Equity Analyses](#).

DATA SOURCES

Inpatient Discharges (DAD), Ontario Ministry of Health and Long-Term Care, IntelliHEALTH ONTARIO, Extracted March 5, 2019.

Matheson, FI; Ontario Agency for Health Protection and Promotion (Public Health Ontario). 2016 Ontario marginalization index: user guide. Toronto, ON: Providence St. Joseph's and St. Michael's Healthcare; 2018. Joint publication with Public Health Ontario.

Chronic lower respiratory diseases, number of hospitalizations

DEFINITION

Number of hospitalizations in Ontario in 2016 with a most-responsible diagnosis of chronic lower respiratory disease.

Chronic lower respiratory disease hospitalizations identified by ICD-10 codes J40-J47.

Indicator aligns with the APHEO [Chronic Disease Hospitalization Core Indicator](#) and the PHO [Chronic Disease Hospitalization Snapshot](#).

EXCLUSIONS

See [hospitalization data extraction](#).

DATA SOURCES

Inpatient Discharges (DAD), Ontario Ministry of Health and Long-Term Care, IntelliHEALTH ONTARIO, Extracted March 5, 2019.

Chronic lower respiratory diseases, rate of hospitalizations by material deprivation

DEFINITION

Crude rate of hospitalizations in Ontario in 2016 with a most-responsible diagnosis of chronic lower respiratory disease (per 100,000 population), stratified by ON-Marg material deprivation quintile.

Chronic lower respiratory disease hospitalizations identified by ICD-10 codes J40-J47, aligning with the APHEO [Chronic Disease Hospitalization Core Indicator](#) and the PHO [Chronic Disease Hospitalization Snapshot](#).

CALCULATION

Rates were calculated for each quintile of material deprivation, by dividing the number of chronic lower respiratory disease hospitalizations within the quintile by the population of the quintile. For example, for quintile 1:

$$\left(\frac{\text{Number of chronic lower respiratory disease hospitalizations in quintile 1}}{\text{Population in quintile 1}} \right) \times 100,000$$

95% confidence intervals were calculated using a Poisson approximation of the binomial distribution.

EXCLUSIONS

- See [hospitalization data extraction](#)
- Additional exclusions:
 - Cases with invalid or missing postal code
 - Dissemination areas with missing data (i.e., no assigned quintile)

ANALYSIS

Significant inequalities in rates of death were determined by the summary measures of inequality SII and RII mean, as described above in the section on [Health Equity Analyses](#).

DATA SOURCES

Inpatient Discharges (DAD), Ontario Ministry of Health and Long-Term Care, IntelliHEALTH ONTARIO, Extracted March 5, 2019.

Matheson, FI; Ontario Agency for Health Protection and Promotion (Public Health Ontario). 2016 Ontario marginalization index: user guide. Toronto, ON: Providence St. Joseph's and St. Michael's Healthcare; 2018. Joint publication with Public Health Ontario.

Diabetes, number of hospitalizations

DEFINITION

Number of hospitalizations in Ontario in 2016 with a most-responsible diagnosis of diabetes.

Diabetes hospitalizations identified by ICD-10 codes E10-E14.

Indicator aligns the APHEO [Chronic Disease Hospitalization Core Indicator](#) and the PHO [Chronic Disease Hospitalization Snapshot](#).

EXCLUSIONS

See [hospitalization data extraction](#).

DATA SOURCES

Inpatient Discharges (DAD), Ontario Ministry of Health and Long-Term Care, IntelliHEALTH ONTARIO, Extracted March 5, 2019.

Diabetes, rate of hospitalizations by material deprivation

DEFINITION

Crude rate of hospitalizations in Ontario in 2016 with a most-responsible diagnosis of diabetes (per 100,000 population), stratified by ON-Marg material deprivation quintile.

Diabetes hospitalizations identified by ICD-10 codes E10-E14, aligning with the APHEO [Chronic Disease Hospitalization Core Indicator](#) and the PHO [Chronic Disease Hospitalization Snapshot](#).

CALCULATION

Rates were calculated for each quintile of material deprivation, by dividing the number of diabetes hospitalizations within the quintile by the population of the quintile. For example, for quintile 1:

$$\left(\frac{\text{Number of diabetes hospitalizations in quintile 1}}{\text{Population in quintile 1}} \right) \times 100,000$$

95% confidence intervals were calculated using a Poisson approximation of the binomial distribution.

EXCLUSIONS

- See [hospitalization data extraction](#)
- Additional exclusions:
 - Cases with invalid or missing postal code
 - Dissemination areas with missing data (i.e., no assigned quintile)

ANALYSIS

Significant inequalities in rates of death were determined by the summary measures of inequality SII and RII mean, as described above in the section on [Health Equity Analyses](#).

DATA SOURCES

Inpatient Discharges (DAD), Ontario Ministry of Health and Long-Term Care, IntelliHEALTH ONTARIO, Extracted March 5, 2019.

Matheson, FI; Ontario Agency for Health Protection and Promotion (Public Health Ontario). 2016 Ontario marginalization index: user guide. Toronto, ON: Providence St. Joseph's and St. Michael's Healthcare; 2018. Joint publication with Public Health Ontario.

TOBACCO PREVALENCE

Current smokers, adults (ages 20+)

DEFINITIONS

Self-reported daily or occasional cigarette smoking in adults ages 20+ in Ontario, 2015/2016.

Current smoking status assigned when SMKDVSTY = 01 or 02.

Indicator aligns with the APHEO [Smoking Status Core Indicator](#) and the PHO [Self-Reported Smoking Snapshot](#).

CALCULATIONS

Ontario:

$$\left(\frac{\text{Weighted number of adults ages 20+ who report smoking daily or occasionally}}{\text{Weighted total number of adults ages 20+}} \right) \times 100$$

Ontario stratified by ON-Marg material deprivation quintile:

Current smoking status was stratified by quintile of material deprivation using PROC SURVEYFREQ. Prevalence of current smoking in each quintile was calculated by dividing the weighted number of adults reporting daily or occasional smoking in the quintile by the weighted total number of adults in the quintile. For example, for quintile 1:

$$\left(\frac{\text{Weighted number of adults ages 20+ who report smoking daily or occasionally in quintile 1}}{\text{Weighted total number of adults ages 20+ in quintile 1}} \right) \times 100$$

Ontario stratified by self-perceived mental health:

Self-perceived mental health assigned as fair/poor when gen_015 = 4 or 5, and as good/very good/excellent when gen_015 = 1, 2, or 3. Dichotomization according to [Statistics Canada methods](#).

Current smoking status was stratified by self-perceived mental health using PROC SURVEYFREQ. Prevalence of current smoking in both categories of self-perceived mental health was calculated by dividing the weighted number of adults reporting daily or occasional smoking in a category by the weighted total number of adults in the category. For example, for fair/poor self-perceived mental health:

$$\left(\frac{\text{Weighted number of adults ages 20+ with fair/poor self-perceived mental health who report smoking daily or occasionally}}{\text{Weighted number of adults ages 20+ with fair/poor self-perceived mental health}} \right) \times 100$$

PROC SURVEYFREQ procedure was used to calculate 95% CIs with bootstrapping (1000 replicates).

EXCLUSIONS

- Respondents in non-response categories (refusal, don't know, not stated) for required questions
- For stratification by ON-Marg material deprivation only:
 - Dissemination areas with missing data (i.e., no assigned quintile)

ANALYSES

Significant inequalities in prevalence of disease were determined by Rao-Scott Chi-Square tests, as described above in the section on [Health Equity Analyses](#). Significant differences in prevalence of disease by self-perceived mental health were determined by Rao-Scott Chi-Square tests.

DATA SOURCES

Canadian Community Health Survey, 2015/2016 cycle, Statistics Canada, Ontario Share File, Distributed by Ontario Ministry of Health and Long-Term Care.

Matheson, FI; Ontario Agency for Health Protection and Promotion (Public Health Ontario). 2016 Ontario marginalization index: user guide. Toronto, ON: Providence St. Joseph's and St. Michael's Healthcare; 2018. Joint publication with Public Health Ontario.

Current smokers, youth (12–19)

DEFINITION

Self-reported daily or occasional cigarette smoking in youth ages 12–19 in Ontario, 2015/2016.

Current smoking status assigned when SMKDVSTY = 01 or 02.

Indicator aligns with the APHEO [Smoking Status Core Indicator](#) and the PHO [Self-reported smoking Snapshot](#).

CALCULATION

Ontario:

$$\left(\frac{\text{Weighted number of youth ages 12–19 who report smoking daily or occasionally}}{\text{Weighted total number of youth ages 12–19}} \right) \times 100$$

Ontario stratified by ON-Marg material deprivation quintile:

Current smoking status was stratified by quintile of material deprivation using PROC SURVEYFREQ. Prevalence of current smoking in each quintile was calculated by dividing the weighted number of youth reporting daily or occasional smoking in the quintile by the weighted total number of youth in the quintile. For example, for quintile 1:

$$\left(\frac{\text{Weighted number of youth ages 12–19 who report smoking daily or occasionally in quintile 1}}{\text{Weighted total number of youth ages 12–19 in quintile 1}} \right) \times 100$$

Ontario stratified by self-perceived mental health:

Self-perceived mental health assigned as fair/poor when gen_015 = 4 or 5, and as good/very good/excellent when gen_015 = 1, 2, or 3. Dichotomization according to [Statistics Canada methods](#).

Current smoking status was stratified by self-perceived mental health using PROC SURVEYFREQ. Prevalence of current smoking in both categories of self-perceived mental health was calculated by dividing the weighted number of youth reporting daily or occasional smoking in a category by the weighted total number of youth in the category. For example, for fair/poor self-perceived mental health:

$$\left(\frac{\text{Weighted number of youth ages 12–19 with fair/poor self-perceived mental health who report smoking daily or occasionally}}{\text{Weighted number of youth ages 12–19 with fair/poor self-perceived mental health}} \right) \times 100$$

PROC SURVEYFREQ procedure was used to calculate 95% CIs with bootstrapping (1000 replicates).

EXCLUSIONS

- Respondents in non-response categories (refusal, don't know, not stated) for required questions
- For stratification by ON-Marg material deprivation only:
 - Dissemination areas with missing data (i.e., no assigned quintile)

ANALYSIS

Significant inequalities in prevalence of disease were determined by Rao-Scott Chi-Square tests, as described above in the section on [Health Equity Analyses](#). Significant differences in prevalence of disease by self-perceived mental health were determined by Rao-Scott Chi-Square tests.

DATA SOURCES

Canadian Community Health Survey, 2015/2016 cycle, Statistics Canada, Ontario Share File, Distributed by Ontario Ministry of Health and Long-Term Care.

Matheson, FI; Ontario Agency for Health Protection and Promotion (Public Health Ontario). 2016 Ontario marginalization index: user guide. Toronto, ON: Providence St. Joseph's and St. Michael's Healthcare; 2018. Joint publication with Public Health Ontario.

ALCOHOL PREVALENCE

Alcohol consumption (Canada's Low-Risk Alcohol Drinking Guidelines), adults (ages 19+)

DEFINITION

Self-reported alcohol consumption in excess of Canada's Low-Risk Alcohol Drinking Guidelines (LRADG), in adults ages 19+ in Ontario, 2015/2016.

Alcohol consumption exceeding LRADG for chronic disease defined as reporting any of the following: daily consumption of more than 2 drinks for females or 3 drinks for males on any day in the past week or any consumption of alcohol on 6 or more days per week (ALW_010, ALW_015, ALW_020, ALW_025, ALW_030, ALW_035, ALW_040); or weekly consumption above 10 drinks for females or 15 drinks for males (ALWDVWKY).

Indicator aligns with the APHEO [Drinking in Excess of the Low-Risk Alcohol Drinking Guidelines Core Indicator](#) and the PHO [Self-Reported Alcohol Use Snapshot](#).

CALCULATION

Ontario:

$$\left(\frac{\text{Weighted number of adults ages 19+ who exceeded LRADG}}{\text{Weighted total number of adults ages 19+}} \right) \times 100$$

Ontario stratified by ON-Marg material deprivation quintile:

Alcohol consumption status was stratified by quintile of material deprivation using PROC SURVEYFREQ. Prevalence of alcohol consumption exceeding LRADG in each quintile was calculated by dividing the weighted number of adults reporting exceeding the LRDG in the quintile by the weighted total number of adults in the quintile. For example, for quintile 1:

$$\left(\frac{\text{Weighted number of adults ages 19+ who exceeded LRADG in quintile 1}}{\text{Weighted total number of adults ages 19+ in quintile 1}} \right) \times 100$$

Ontario stratified by self-perceived mental health:

Self-perceived mental health assigned as fair/poor when gen_015 = 4 or 5, and as good/very good/excellent when gen_015 = 1, 2, or 3. Dichotomization according to [Statistics Canada methods](#).

Alcohol consumption status was stratified by self-perceived mental health using PROC SURVEYFREQ. Prevalence of alcohol consumption exceeding LRADG in both categories of self-perceived mental health was calculated by dividing the weighted number of adults reporting exceeding the LRADG in a category by the weighted total number of adults in the category. For example, for fair/poor self-perceived mental health:

$$\left(\frac{\text{Weighted number of adults ages 19+ with fair/poor self-perceived mental health who exceeded LRADG}}{\text{Weighted number of adults ages 19+ with fair/poor self-perceived mental health}} \right) \times 100$$

PROC SURVEYFREQ procedure was used to calculate 95% CIs with bootstrapping (1000 replicates).

EXCLUSIONS

- Respondents in non-response categories (refusal, don't know, not stated) for required questions
- Respondents who are pregnant or breastfeeding
- For stratification by ON-Marg material deprivation only:
 - Dissemination areas with missing data (i.e., no assigned quintile)

ANALYSIS

Significant inequalities in prevalence of disease were determined by Rao-Scott Chi-Square tests, as described above in the section on [Health Equity Analyses](#). Significant differences in prevalence of disease by self-perceived mental health were determined by Rao-Scott Chi-Square tests.

DATA SOURCES

Canadian Community Health Survey, 2015/2016 cycle, Statistics Canada, Ontario Share File, Distributed by Ontario Ministry of Health and Long-Term Care.

Matheson, FI; Ontario Agency for Health Protection and Promotion (Public Health Ontario). 2016 Ontario marginalization index: user guide. Toronto, ON: Providence St. Joseph's and St. Michael's Healthcare; 2018. Joint publication with Public Health Ontario.

Underage drinking, youth (ages 12–18)

DEFINITION

Self-reported underage drinking, in youth ages 12–18 in Ontario, 2015/2016.

Underage drinking was defined as any drinking in the past 12 months (when ALC_010 = 1).

Indicator aligns with the APHEO [Underage Alcohol Drinking Core Indicator](#) and the PHO [Self-Reported Alcohol Use Snapshot](#).

CALCULATION

Ontario:

$$\left(\frac{\text{Weighted number of youth ages 12–18 who drank alcohol}}{\text{Weighted total number of youth ages 12–18}} \right) \times 100$$

Ontario stratified by ON-Marg material deprivation quintile:

Underage drinking status was stratified by quintile of material deprivation using PROC SURVEYFREQ. Prevalence of underage drinking in each quintile was calculated by dividing the weighted number of youth reporting drinking in the quintile by the weighted total number of youth in the quintile. For example, for quintile 1:

$$\left(\frac{\text{Weighted number of youth ages 12–18 who drank alcohol in quintile 1}}{\text{Weighted total number of youth ages 12–18 in quintile 1}} \right) \times 100$$

Ontario stratified by self-perceived mental health:

Self-perceived mental health assigned as fair/poor when gen_015 = 4 or 5, and as good/very good/excellent when gen_015 = 1, 2, or 3. Dichotomization according to [Statistics Canada methods](#).

Underage drinking status was stratified by self-perceived mental health using PROC SURVEYFREQ. Prevalence of underage drinking in both categories of self-perceived mental health was calculated by dividing the weighted number of youth reporting drinking in a category by the weighted total number of youth in the category. For example, for fair/poor self-perceived mental health:

$$\left(\frac{\text{Weighted number of youth ages 12–18 with fair/poor self-perceived mental health who drank alcohol}}{\text{Weighted number of youth ages 12–18 with fair/poor self-perceived mental health}} \right) \times 100$$

PROC SURVEYFREQ procedure was used to calculate 95% CIs with bootstrapping (1000 replicates).

EXCLUSIONS

- Respondents in non-response categories (refusal, don't know, not stated) for required questions
- Respondents who are pregnant or breastfeeding
- For stratification by ON-Marg material deprivation only:
 - Dissemination areas with missing data (i.e., no assigned quintile)

ANALYSIS

Significant inequalities in prevalence of disease were determined by Rao-Scott Chi-Square tests, as described above in the section on [Health Equity Analyses](#). Significant differences in prevalence of disease by self-perceived mental health were determined by Rao-Scott Chi-Square tests.

DATA SOURCES

Canadian Community Health Survey, 2015/2016 cycle, Statistics Canada, Ontario Share File, Distributed by Ontario Ministry of Health and Long-Term Care.

Matheson, FI; Ontario Agency for Health Protection and Promotion (Public Health Ontario). 2016 Ontario marginalization index: user guide. Toronto, ON: Providence St. Joseph's and St. Michael's Healthcare; 2018. Joint publication with Public Health Ontario.

PHYSICAL ACTIVITY PREVALENCE

Inadequate physical activity (Canadian Physical Activity Guidelines), adults (ages 18+), adults (ages 18+)

DEFINITION

Self-reported inadequate physical activity according to Canadian Physical Activity Guidelines (CPAG) in adults ages 18+ in Ontario, 2015/2016.

Inadequate physical activity according to CPAG for adults defined as not having at least 150 minutes of moderate- to vigorous-intensity aerobic physical activity per week, in bouts of 10 minutes or more (when PAADVACV = 2 or 3).

Indicator aligns with the [Public Health Agency of Canada's Physical Activity, Sedentary Behaviour and Sleep \(PASS\) Indicators](#).

CALCULATION

Ontario:

$$\left(\frac{\text{Weighted number of adults ages 18+ who report inadequate physical activity according to CPAG}}{\text{Weighted total number of adults ages 18+}} \right) \times 100$$

Ontario stratified by ON-Marg material deprivation quintile:

Physical activity status was stratified by quintile of material deprivation using PROC SURVEYFREQ. Prevalence of inadequate physical activity in each quintile was calculated by dividing the weighted number of adults reporting inadequate physical activity in the quintile by the weighted total number of adults in the quintile. For example, for quintile 1:

$$\left(\frac{\text{Weighted number of adults ages 18+ who report inadequate physical activity according to CPAG in quintile 1}}{\text{Weighted total number of adults ages 18+ in quintile 1}} \right) \times 100$$

Ontario stratified by self-perceived mental health:

Self-perceived mental health assigned as fair/poor when gen_015 = 4 or 5, and as good/very good/excellent when gen_015 = 1, 2, or 3. Dichotomization according to [Statistics Canada methods](#).

Physical activity status was stratified by self-perceived mental health using PROC SURVEYFREQ. Prevalence of inadequate physical activity in both categories of self-perceived mental health was calculated by dividing the weighted number of adults reporting inadequate physical activity in a category by the weighted total number of adults in the category. For example, for fair/poor self-perceived mental health:

$$\left(\frac{\text{Weighted number of adults ages 18+ with fair/poor self-perceived mental health who report inadequate physical activity according to CPAG}}{\text{Weighted total number of adults ages 18+ with fair/poor self-perceived mental health}} \right) \times 100$$

PROC SURVEYFREQ procedure was used to calculate 95% CI with bootstrapping (1000 replicates).

EXCLUSIONS

- Respondents in non-response categories (refusal, don't know, not stated) for required questions
- For stratification by ON-Marg material deprivation only:
 - Dissemination areas with missing data (i.e., no assigned quintile)

ANALYSIS

Significant inequalities in prevalence of disease were determined by Rao-Scott Chi-Square tests, as described above in the section on [Health Equity Analyses](#). Significant differences in prevalence of disease by self-perceived mental health were determined by Rao-Scott Chi-Square tests.

DATA SOURCES

Canadian Community Health Survey, 2015/2016 cycle, Statistics Canada, Ontario Share File, Distributed by Ontario Ministry of Health and Long-Term Care.

Matheson, FI; Ontario Agency for Health Protection and Promotion (Public Health Ontario). 2016 Ontario marginalization index: user guide. Toronto, ON: Providence St. Joseph's and St. Michael's Healthcare; 2018. Joint publication with Public Health Ontario.

Recreational screen time, adults (ages 18+)

DEFINITION

Self-reported weekly recreational screen time in adults ages 18+ in Ontario, 2015/2016.

Adult average recreational screen time per week, average reported for adults ages 18+ based on SAC_010, SAC_020, and SAC_025.

Indicator aligns with the [Public Health Agency of Canada's Physical Activity, Sedentary Behaviour and Sleep \(PASS\) Indicators](#).

CALCULATIONS

Average recreational screen time for adults ages 18+ calculated for:

1. Ontario
2. Ontario stratified by ON-Marg material deprivation quintile
3. Ontario stratified by self-perceived mental health:
 - Self-perceived mental health assigned as fair/poor when gen_015 = 4 or 5, and as good/very good/excellent when gen_015 = 1, 2, or 3.
Dichotomization according to [Statistics Canada methods](#).

PROC SURVEYMEANS procedure was used to calculate 95% CI with bootstrapping (1000 replicates).

EXCLUSIONS

- Respondents in non-response categories (refusal, don't know, not stated) for required questions
- For stratification by ON-Marg material deprivation only:
 - Dissemination areas with missing data (i.e., no assigned quintile)

ANALYSIS

Significant inequalities in prevalence of disease were determined by linear regression, as described above in the section on [Health Equity Analyses](#). Significant differences in prevalence of disease by self-perceived mental health were also determined by linear regression.

DATA SOURCES

Canadian Community Health Survey, 2015/2016 cycle, Statistics Canada, Ontario Share File, Distributed by Ontario Ministry of Health and Long-Term Care.

Matheson, FI; Ontario Agency for Health Protection and Promotion (Public Health Ontario). 2016 Ontario marginalization index: user guide. Toronto, ON: Providence St. Joseph's and St. Michael's Healthcare; 2018. Joint publication with Public Health Ontario.

Inadequate physical activity, youth (ages 12–17)

DEFINITION

Self-reported inadequate physical activity according to Canadian 24-Hour Movement Guidelines for Children and Youth in youth ages 12–17 in Ontario, 2015/2016.

Inadequate physical activity according to Canadian 24-Hour Movement Guidelines for Children and Youth (ages 5–17) for youth defined as not having at least 60 minutes of moderate-to-vigorous physical activity each day (when PAYDVPAl = 0 or 2).

Indicator aligns with the [Public Health Agency of Canada's Physical Activity, Sedentary Behaviour and Sleep \(PASS\) Indicators](#).

CALCULATION

Ontario:

$$\left(\frac{\text{Weighted number of youth ages 12–17 who report inadequate physical activity}}{\text{Weighted total number of youth ages 12–17}} \right) \times 100$$

Ontario stratified by ON-Marg material deprivation quintile:

Physical activity status was stratified by quintile of material deprivation using PROC SURVEYFREQ. Prevalence of inadequate physical activity in each quintile was calculated by dividing the weighted number of youth reporting inadequate physical activity in the quintile by the weighted total number of youth in the quintile. For example, for quintile 1:

$$\left(\frac{\text{Weighted number of youth ages 12–17 who report inadequate physical activity in quintile 1}}{\text{Weighted total number of youth ages 12–17 in quintile 1}} \right) \times 100$$

Ontario stratified by self-perceived mental health:

Self-perceived mental health assigned as fair/poor when gen_015 = 4 or 5, and as good/very good/excellent when gen_015 = 1, 2, or 3. Dichotomization according to [Statistics Canada methods](#).

Physical activity status was stratified by self-perceived mental health using PROC SURVEYFREQ. Prevalence of inadequate physical activity in both categories of self-perceived mental health was calculated by dividing the weighted number of youth reporting inadequate physical activity in a category by the weighted total number of youth in the category. For example, for fair/poor self-perceived mental health:

$$\left(\frac{\text{Weighted number of youth with fair/poor self-perceived mental health who report inadequate physical activity according to CPAG}}{\text{Weighted total number of youth ages 12–17 with fair/poor self-perceived mental health}} \right) \times 100$$

PROC SURVEYFREQ procedure was used to calculate 95% CI with bootstrapping (1000 replicates).

EXCLUSIONS

- Respondents in non-response categories (refusal, don't know, not stated) for required questions
- For stratification by ON-Marg material deprivation only:
 - Dissemination areas with missing data (i.e., no assigned quintile)

ANALYSIS

Significant inequalities in prevalence of disease were determined by Rao-Scott Chi-Square tests, as described above in the section on [Health Equity Analyses](#). Significant differences in prevalence of disease by self-perceived mental health were determined by Rao-Scott Chi-Square tests.

DATA SOURCES

Canadian Community Health Survey, 2015/2016 cycle, Statistics Canada, Ontario Share File, Distributed by Ontario Ministry of Health and Long-Term Care.

Matheson, FI; Ontario Agency for Health Protection and Promotion (Public Health Ontario). 2016 Ontario marginalization index: user guide. Toronto, ON: Providence St. Joseph's and St. Michael's Healthcare; 2018. Joint publication with Public Health Ontario.

Exceeding recreational screen time guidelines, youth (ages 12–17)

DEFINITION

Self-reported exceeding recreational screen time guidelines from the Canadian 24-Hour Movement Guidelines for Children and Youth in youth ages 12–17 in Ontario, 2015/2016.

Recreational screen time exceeding the Canadian 24-Hour Movement Guidelines for Children and Youth defined as daily recreational screen time exceeded 2 hours. Exceeding guidelines assigned when the sum of SAC_010, SAC_020, and SAC_025 > 14.

Indicator aligns with the [Public Health Agency of Canada's Physical Activity, Sedentary Behaviour and Sleep \(PASS\) Indicators](#).

CALCULATION

Ontario:

$$\left(\frac{\text{Weighted number of youth ages 12–17 who report exceeding recreational screen time guidelines}}{\text{Weighted total number of youth ages 12–17}} \right) \times 100$$

Ontario stratified by ON-Marg material deprivation quintile:

Recreational screen time status was stratified by quintile of material deprivation using PROC SURVEYFREQ. Prevalence of exceeding recreational screen time guidelines in each quintile was calculated by dividing the weighted number of youth reporting exceeding guidelines in the quintile by the weighted total number of youth in the quintile. For example, for quintile 1:

$$\left(\frac{\text{Weighted number of youth ages 12–17 who report exceeding recreational screen time guidelines in quintile 1}}{\text{Weighted total number of youth ages 12–17 in quintile 1}} \right) \times 100$$

Ontario stratified by self-perceived mental health:

Self-perceived mental health assigned as fair/poor when gen_015 = 4 or 5, and as good/very good/excellent when gen_015 = 1, 2, or 3. Dichotomization according to [Statistics Canada methods](#).

Recreational screen time status was stratified by self-perceived mental health using PROC SURVEYFREQ. Prevalence of exceeding recreational screen time guidelines in both categories of self-perceived mental health was calculated by dividing the weighted number of youth reporting exceeding guidelines in a category by the weighted total number of youth in the category. For example, for fair/poor self-perceived mental health:

$$\left(\frac{\text{Weighted number of youth ages 12–17 with fair/poor self-perceived mental health who report exceeding recreational screen time guidelines}}{\text{Weighted total number of youth ages 12–17 with fair/poor self-perceived mental health}} \right) \times 100$$

PROC SURVEYFREQ procedure was used to calculate 95% CI with bootstrapping (1000 replicates).

EXCLUSIONS

- Respondents in non-response categories (refusal, don't know, not stated) for required questions
- For stratification by ON-Marg material deprivation only:
 - Dissemination areas with missing data (i.e., no assigned quintile)

ANALYSIS

Significant inequalities in prevalence of disease were determined by Rao-Scott Chi-Square tests, as described above in the section on [Health Equity Analyses](#). Significant differences in prevalence of disease by self-perceived mental health were determined by Rao-Scott Chi-Square tests.

DATA SOURCES

Canadian Community Health Survey, 2015/2016 cycle, Statistics Canada, Ontario Share File, Distributed by Ontario Ministry of Health and Long-Term Care.

Matheson, FI; Ontario Agency for Health Protection and Promotion (Public Health Ontario). 2016 Ontario marginalization index: user guide. Toronto, ON: Providence St. Joseph's and St. Michael's Healthcare; 2018. Joint publication with Public Health Ontario.

HEALTHY EATING PREVALENCE

Inadequate vegetable and fruit consumption, adults (ages 20+)

DEFINITION

Self-reported inadequate vegetable and fruit consumption in adults ages 20+ in Ontario, 2015/2016.

Inadequate vegetable and fruit intake defined as consumption less than 5 times per day (when FVCDVGDT = 1).

Indicator aligns with the APHEO [Vegetable and Fruit Consumption Core Indicator](#) and the PHO [Self-Reported Nutrition and Healthy Weights Snapshot](#).

CALCULATION

Ontario:

$$\left(\frac{\text{Weighted number of adults ages 20+ who report inadequate vegetable and fruit consumption}}{\text{Weighted total number of adults ages 20+}} \right) \times 100$$

Ontario stratified by ON-Marg material deprivation quintile:

Vegetable and fruit consumption status was stratified by quintile of material deprivation using PROC SURVEYFREQ. Prevalence of inadequate vegetable and fruit consumption in each quintile was calculated by dividing the weighted number of adults reporting inadequate vegetable and fruit consumption in the quintile by the weighted total number of adults in the quintile. For example, for quintile 1:

$$\left(\frac{\text{Weighted number of adults ages 20+ who report inadequate vegetable and fruit consumption in quintile 1}}{\text{Weighted total number of adults ages 20+ in quintile 1}} \right) \times 100$$

Ontario stratified by self-perceived mental health:

Self-perceived mental health assigned as fair/poor when gen_015 = 4 or 5, and as good/very good/excellent when gen_015 = 1, 2, or 3. Dichotomization according to [Statistics Canada methods](#).

Vegetable and fruit consumption status was stratified by self-perceived mental health using PROC SURVEYFREQ. Prevalence of inadequate vegetable and fruit consumption in both categories of self-perceived mental health was calculated by dividing the weighted number of adults reporting inadequate vegetable and fruit consumption in a category by the weighted total number of adults in the category. For example, for fair/poor self-perceived mental health:

$$\left(\frac{\text{Weighted number of adults ages 20+ with fair/poor self-perceived mental health who report inadequate vegetable and fruit consumption}}{\text{Weighted number of adults ages 20+ with fair/poor self-perceived mental health}} \right) \times 100$$

PROC SURVEYFREQ procedure was used to calculate 95% CI with bootstrapping (1000 replicates).

EXCLUSIONS

- Respondents in non-response categories (refusal, don't know, not stated) for required questions
- For stratification by ON-Marg material deprivation only:
 - Dissemination areas with missing data (i.e., no assigned quintile)

ANALYSIS

Significant inequalities in prevalence of disease were determined by Rao-Scott Chi-Square tests, as described above in the section on [Health Equity Analyses](#). Significant differences in prevalence of disease by self-perceived mental health were determined by Rao-Scott Chi-Square tests.

DATA SOURCES

Canadian Community Health Survey, 2015/2016 cycle, Statistics Canada, Ontario Share File, Distributed by Ontario Ministry of Health and Long-Term Care.

Matheson, FI; Ontario Agency for Health Protection and Promotion (Public Health Ontario). 2016 Ontario marginalization index: user guide. Toronto, ON: Providence St. Joseph's and St. Michael's Healthcare; 2018. Joint publication with Public Health Ontario.

Inadequate vegetable and fruit consumption, youth (ages 12–19)

DEFINITION

Self-reported inadequate vegetable and fruit consumption in youth ages 12–19 in Ontario, 2015/2016.

Inadequate vegetable and fruit intake defined as consumption less than 5 times per day (when FVCDVGDT = 1).

Indicator aligns with the APHEO [Vegetable and Fruit Consumption Core Indicator](#) and the PHO [Self-Reported Nutrition and Healthy Weights Snapshot](#).

CALCULATION

Ontario:

$$\left(\frac{\text{Weighted number of youth ages 12–19 who report inadequate vegetable and fruit consumption}}{\text{Weighted total number of youth ages 12–19}} \right) \times 100$$

Ontario stratified by ON-Marg material deprivation quintile:

Vegetable and fruit consumption status was stratified by quintile of material deprivation using PROC SURVEYFREQ. Prevalence of inadequate vegetable and fruit consumption in each quintile was calculated by dividing the weighted number of youth reporting inadequate vegetable and fruit consumption in the quintile by the weighted total number of youth in the quintile. For example, for quintile 1:

$$\left(\frac{\text{Weighted number of youth ages 12–19 who report inadequate vegetable and fruit consumption in quintile 1}}{\text{Weighted total number of youth ages 12–19 in quintile 1}} \right) \times 100$$

Ontario stratified by self-perceived mental health:

Self-perceived mental health assigned as fair/poor when gen_015 = 4 or 5, and as good/very good/excellent when gen_015 = 1, 2, or 3. Dichotomization according to [Statistics Canada methods](#).

Vegetable and fruit consumption status was stratified by self-perceived mental health using PROC SURVEYFREQ. Prevalence of inadequate vegetable and fruit consumption in both categories of self-perceived mental health was calculated by dividing the weighted number of youth reporting inadequate vegetable and fruit

consumption in a category by the weighted total number of youth in the category. For example, for fair/poor self-perceived mental health:

$$\left(\frac{\text{Weighted number of youth ages 12–19 with fair/poor self-perceived mental health who report inadequate vegetable and fruit consumption}}{\text{Weighted total number of youth ages 12–19 with fair/poor self-perceived mental health}} \right) \times 100$$

95% confidence intervals were calculated using PROC SURVEYFREQ with bootstrapping (1000 replicates).

EXCLUSIONS

- Respondents in non-response categories (refusal, don't know, not stated) for required questions
- For stratification by ON-Marg material deprivation only:
 - Dissemination areas with missing data (i.e., no assigned quintile)

ANALYSIS

Significant inequalities in prevalence of disease were determined by Rao-Scott Chi-Square tests, as described above in the section on [Health Equity Analyses](#). Significant differences in prevalence of disease by self-perceived mental health were determined by Rao-Scott Chi-Square tests.

DATA SOURCES

Canadian Community Health Survey, 2015/2016 cycle, Statistics Canada, Ontario Share File, Distributed by Ontario Ministry of Health and Long-Term Care.

Matheson, FI; Ontario Agency for Health Protection and Promotion (Public Health Ontario). 2016 Ontario marginalization index: user guide. Toronto, ON: Providence St. Joseph's and St. Michael's Healthcare; 2018. Joint publication with Public Health Ontario.

PREVALENCE OF MULTIPLE RISK FACTORS

Multiple risk factors, adults (ages 18+)

DEFINITION

Self-reported prevalence of 0–4 chronic disease risk factors in adults ages 18+ in Ontario, 2015/2016.

Risk factors included:

1. Self-reported daily or occasional cigarette smoking
2. Self-reported alcohol consumption in excess of Canada's Low-Risk Alcohol Drinking Guidelines (adults ages 19+); or self-reported underage drinking (adults ages 18 years old).
3. Self-reported inadequate vegetable and fruit consumption
4. Self-reported inadequate physical activity according to Canadian Physical Activity Guidelines (CPAG)

CALCULATION

Ontario:

The number of risk factors present was summed for each individual. Prevalence of 0, 1, 2, 3, and 4 risk factors was calculated by dividing the weighted number of adults with each number of risk factors by the weighted total number of adults. For example, for the prevalence of adults with 0 risk factors:

$$\left(\frac{\text{Weighted number of adults ages 18+ reporting 0 risk factors}}{\text{Weighted total number of adults ages 18+}} \right) \times 100$$

Ontario stratified by ON-Marg material deprivation quintile:

Multiple risk factor status was stratified by quintile of material deprivation using PROC SURVEYFREQ. Prevalence of having 0–1 or 2–4 risk factors in each quintile was calculated by dividing the weighted number of adults reporting 0–1 or 2–4 risk factors in the quintile by the weighted total number of adults in the quintile. For example, for 2–4 risk factors in quintile 1:

$$\left(\frac{\text{Weighted number of adults ages 18+ reporting 2–4 risk factors in quintile 1}}{\text{Weighted total number of adults ages 18+ in quintile 1}} \right) \times 100$$

Ontario stratified by self-perceived mental health:

Self-perceived mental health assigned as fair/poor when gen_015 = 4 or 5, and as good/very good/excellent when gen_015 = 1, 2, or 3. Dichotomization according to [Statistics Canada methods](#).

Multiple risk factor status was stratified by self-perceived mental health using PROC SURVEYFREQ. Prevalence of having 0–1 or 2–4 risk factors in both categories of self-perceived mental health was calculated by dividing the weighted number of adults reporting 0–1 or 2–4 risk factors in a category by the weighted total number of adults in the category. For example, for 2–4 risk factors among adults with fair/poor self-perceived mental health:

$$\left(\frac{\text{Weighted number of adults ages 18+ with fair/poor self-perceived mental health who report 2–4 risk factors}}{\text{Weighted total number of adults ages 18+ with fair/poor self-perceived mental health}} \right) \times 100$$

PROC SURVEYFREQ procedure was used to calculate 95% CI with bootstrapping (1000 replicates).

ANALYSIS

Significant inequalities in prevalence of risk factors were determined by Rao-Scott Chi-Square tests, as described above in the section on [Health Equity Analyses](#). Significant differences in prevalence of risk factors by self-perceived mental health were determined by Rao-Scott Chi-Square tests.

DATA SOURCES

Canadian Community Health Survey, 2015/2016 cycle, Statistics Canada, Ontario Share File, Distributed by Ontario Ministry of Health and Long-Term Care.

Matheson, FI; Ontario Agency for Health Protection and Promotion (Public Health Ontario). 2016 Ontario marginalization index: user guide. Toronto, ON: Providence St. Joseph's and St. Michael's Healthcare; 2018. Joint publication with Public Health Ontario.

Multiple risk factors, youth (ages 12–17)

DEFINITION

Self-reported prevalence of 0–4 chronic disease risk factors in youth ages 12–17 in Ontario, 2015/2016.

Risk factors included:

1. Self-reported daily or occasional cigarette smoking
2. Self-reported underage drinking
3. Self-reported inadequate vegetable and fruit consumption
4. Self-reported inadequate physical activity according to Canadian 24-Hour Movement Guidelines for Children and Youth

CALCULATION

Ontario:

The number of risk factors present was summed for each individual. Prevalence of 0, 1, 2, 3, and 4 risk factors was calculated by dividing the weighted number of youth with each number of risk factors by the weighted total number of youth. For example, for the prevalence of youth with 0 risk factors:

$$\left(\frac{\text{Weighted number of youth ages 12–17 reporting 0 risk factors}}{\text{Weighted total number of youth ages 12–17}} \right) \times 100$$

Ontario stratified by ON-Marg material deprivation quintile:

Multiple risk factor status was stratified by quintile of material deprivation using PROC SURVEYFREQ. Prevalence of having 0–1 or 2–4 risk factors in each quintile was calculated by dividing the weighted number of youth reporting 0–1 or 2–4 risk factors in the quintile by the weighted total number of youth in the quintile. For example, for 2–4 risk factors in quintile 1:

$$\left(\frac{\text{Weighted number of youth ages 12–17 reporting 2–4 risk factors in quintile 1}}{\text{Weighted total number of youth ages 12–17 in quintile 1}} \right) \times 100$$

Ontario stratified by self-perceived mental health:

Self-perceived mental health assigned as fair/poor when gen_015 = 4 or 5, and as good/very good/excellent when gen_015 = 1, 2, or 3. Dichotomization according to [Statistics Canada methods](#).

Multiple risk factor status was stratified by self-perceived mental health using PROC SURVEYFREQ. Prevalence of having 0–1 or 2–4 risk factors in both categories of self-perceived mental health was calculated by dividing the weighted number of youth reporting 0–1 or 2–4 risk factors in a category by the weighted total number of youth in the category. For example, for 2–4 risk factors among youth with fair/poor self-perceived mental health:

$$\left(\frac{\text{Weighted number of youth ages 12–17 with fair/poor self-perceived mental health reporting 2–4 risk factors}}{\text{Weighted total number of youth ages 12–17 with fair/poor self-perceived mental health}} \right) \times 100$$

PROC SURVEYFREQ procedure was used to calculate 95% CI with bootstrapping (1000 replicates).

ANALYSIS

Significant inequalities in prevalence of risk factors were determined by Rao-Scott Chi-Square tests, as described above in the section on [Health Equity Analyses](#). Significant differences in prevalence of risk factors by self-perceived mental health were determined by Rao-Scott Chi-Square tests.

DATA SOURCES

Canadian Community Health Survey, 2015/2016 cycle, Statistics Canada, Ontario Share File, Distributed by Ontario MOHLTC.

Matheson, FI; Ontario Agency for Health Protection and Promotion (Public Health Ontario). 2016 Ontario marginalization index: user guide. Toronto, ON: Providence St. Joseph's and St. Michael's Healthcare; 2018. Joint publication with Public Health Ontario.

ECONOMIC BURDEN OF RISK FACTORS

Methods

The following procedure was used to generate estimates of the economic burden of the four risk factors of interest (tobacco use, alcohol consumption, physical inactivity and unhealthy eating) in Ontario:

1. A research librarian conducted a systematic search of the literature published between 2013 and 2018 in the databases MEDLINE, EMBASE and CINAHL. A combination of economic and risk factor search terms were used (see Table 1 for the detailed search strategies). A search for grey literature was also performed.
2. Studies were sorted by title and abstract by one reviewer; they were included in the review if they:
 - were an original research paper or systematic review;
 - contained annual estimates of the economic burden for one or more of the risk factors that was not restricted to a specific disease or outcome (e.g., diabetes);
 - examined an entire population as opposed to sub-populations such as children, seniors or military veterans;
 - contained estimates for industrialized countries or regions such as Canada, United States, Europe, Australia and New Zealand; and
 - were prevalence-based as opposed to incidence-based.
3. Estimates were extracted for each risk factor for direct health care costs and indirect costs related to lost productivity. Several studies also included other costs (i.e., law enforcement) but these were not included.
4. Estimates, which were usually presented as total direct and indirect costs, were converted to cost per capita using population estimates for the country or region in the year of costing.
 - Direct healthcare costs varied, sometimes substantially, across studies, but typically included costs incurred from in- and out-patient services and pharmaceuticals.
 - Indirect costs varied slightly across studies, but typically included the monetary value associated with lost productivity due to disability and premature mortality.
5. Estimates of cost per capita were converted to Canadian dollars in the year of costing using the average currency exchange for that year from the Bank of Canada.^{1,2}
6. Estimates of cost per capita in Canadian dollars in the year of costing were inflated to 2018 Canadian dollars using the Bank of Canada inflation calculator, which uses the Statistics Canada Consumer Price Index.³

Estimates of cost per capita in 2018 Canadian dollars were multiplied by the population of Ontario in 2018 (n=14,322,757)⁴ to obtain an estimated burden for Ontario.

Table 1:
Search strategies used for assessing the economic burden of selected chronic disease risk factors by database

Concept/ risk factor	MEDLINE search terms	EMBASE search terms	CINAHL search terms
Economic	Economics “Costs and Cost Analysis” Cost of Illness exp Health Care Costs exp Health Expenditures Models, Economic Economics, Hospital Economics, Medical Economics, Nursing	economic aspect economics health economics economic evaluation “cost” “health care cost” “cost of illness”	MH “Economics” MH “Economic Aspects of Illness” MH “Health Care Costs+” MH “Costs and Cost Analysis”
Tobacco use	Smoking exp Tobacco exp “Tobacco Use Cessation” “Tobacco Use Disorder” “Tobacco Smoke Pollution”	exp Smoking Tobacco Smokeless Tobacco Tobacco Dependence Smoking Cessation Cigarette Smoke Tobacco Smoke “Smoking and Smoking Related Phenomena”	MH “Smoking+” MH “Passive Smoking” MH “Smoking Cessation” MH “Tobacco+”
Alcohol consumption	Alcohol Drinking exp Alcohol-Related Disorders exp Alcohol-Induced Disorders Alcoholic Intoxication Alcoholism exp Alcoholic Beverages	Drinking Behavior Alcohol Consumption Alcohol Abuse Alcohol Abstinence Alcoholism Alcoholic Intoxication Alcoholic Beverage	MH “Alcohol Drinking” MH “Alcohol-Related Disorders+” MH “Alcoholics” MH “Alcoholic Beverages”
Physical inactivity	exp Exercise Physical Exertion Motor Activity Overweight Obesity Body Mass Index Life Style Sedentary Lifestyle Exercise Therapy Weight Loss Physical Fitness	exp Exercise Fitness Physical Activity Motor Activity Obesity Lifestyle Lifestyle Modification Sedentary Lifestyle Body Mass Weight Reduction	MH Exercise+ MH Physical activity MH Physical Fitness+ MH Motor Activity MH Life style+ MH Body weight+ MH Body mass index MH Exertion

Concept/ risk factor	MEDLINE search terms	EMBASE search terms	CINAHL search terms
Unhealthy eating	exp Diet Food Habits Energy Intake Caloric Restriction exp Diet Therapy Nutrition Therapy Nutritional Status Nutritional Physiological Phenomena Food Overnutrition Eating Diet Therapy.fs	exp Diet exp Feeding Behavior exp Dietary Intake Food Intake Energy Consumption Caloric Restriction exp Diet Therapy exp Nutrition exp Food Overnutrition Eating	MH "Diet+" MH "Food Habits" MH "Food+" MH "Energy Intake" MH "Food Intake+" MH "Nutrition" MH "Nutritional Status" MH "Hyperphagia" MH "Eating"

Results

A total of 2,308 citations were returned by a systematic search of MEDLINE, EMBASE and CINAHL for estimates of the economic burden of the four risk factors. Fifteen studies were retained in this review based on the inclusion criteria. Five additional studies were identified through the grey literature search. Results are summarized in Table 2. Supplementary information on the definitions of direct and indirect costs for each study are provided in Table 3.

These estimates should be interpreted cautiously because risk factors were defined differently across studies, costing techniques varied, and studies differed in their definition of direct and indirect costs. For these reasons, many estimates reported here are not directly comparable. Additionally, the estimates are limited because they account for costs incurred by all risk-factor-related diseases and injuries, not just cancer, cardiovascular disease, chronic respiratory disease and diabetes.

Table 2:

Summary of direct healthcare costs and productivity losses (indirect costs) due to four risk factors: tobacco smoking, alcohol consumption, physical inactivity and unhealthy eating, in 2018 Canadian dollars (CAD)

First author, year/ Organization, year	Country/ region	Risk factor definition	Direct healthcare costs per capita in country/ region of origin (CAD)	Indirect costs per capita in country/ region of origin (CAD)	Direct healthcare and indirect costs per capita in country/ region of origin (CAD)	Total estimated direct healthcare costs based on the Ontario population (CAD millions) ^a	Total estimated indirect costs based on the Ontario population (CAD millions) ^a	Total estimated costs based on the Ontario population (CAD millions) ^a
Krueger, 2017 ⁵	Canada	Smoking	206.36	398.00	604.36	2,955.70	5,700.41	8,656.12
Cher, 2017 ⁶	Singapore	Smoking	4.53	141.29	145.82	64.91	2,023.69	2,088.60
Fosson, 2014 ⁷	Alabama	Smoking	-	929.70	-	-	13,315.80	-
Ginsberg, 2017 ⁸	Israel	Smoking	67.21	76.42	143.63	962.62	1,094.49	2,057.11
Max, 2016 ⁹	California	Smoking	355.41	297.48	652.89	5,090.45	4,260.76	9,351.21
Tsalapati, 2014 ¹⁰	Greece	Smoking	76.13	-	-	1,090.43	-	-
Canadian Substance Use Costs and Harms Scientific Working Group, 2018 ¹¹	Ontario	Smoking	185.53	178.76	364.29	2,657.31	2,560.29	5,217.60
Dobrescu, 2017 ¹²	Canada	Smoking	206.33	299.54	505.87	2,955.17	4,290.23	7,245.40
Krueger, 2018 ¹³	British Columbia	Smoking	168.46	303.32	471.78	2,412.79	4,344.43	6,757.22
Krueger, 2017 ⁵	Canada	All alcohol consumption	107.52	221.13	328.65	1,540.04	3,167.14	4,707.18
Kopp, 2017 ¹⁴	France	All alcohol consumption	185.72	2,760.53	2,946.25	2,660.04	39,538.38	42,198.42

First author, year/ Organization, year	Country/ region	Risk factor definition	Direct healthcare costs per capita in country/ region of origin (CAD)	Indirect costs per capita in country/ region of origin (CAD)	Direct healthcare and indirect costs per capita in country/ region of origin (CAD)	Total estimated direct healthcare costs based on the Ontario population (CAD millions) ^a	Total estimated indirect costs based on the Ontario population (CAD millions) ^a	Total estimated costs based on the Ontario population (CAD millions) ^a
Sacks, 2015 ¹⁵	United States	Excess alcohol consumption ^b	107.92	681.05	788.97	1,545.77	9,754.51	11,300.28
Verhaeghe, 2017 ¹⁶	Belgium	All alcohol consumption	115.36	81.81	197.18	1,652.31	1,171.81	2,824.12
Canadian Substance Use Costs and Harms Scientific Working Group, 2018 ¹¹	Ontario	All alcohol consumption	114.76	164.90	279.66	1,643.67	2,361.80	4,005.47
Krueger, 2018 ¹³	British Columbia	All alcohol consumption	109.45	218.85	328.29	1,567.57	3,134.50	4,702.07
Krueger, 2017 ⁵	Canada	Physical inactivity ^c	94.78	193.93	288.71	1,357.47	2,777.58	4,135.05
Bolin, 2018 ¹⁷	Sweden	Physical inactivity ^d	35.60	41.20	76.80	509.83	590.12	1,099.95
Dallmeyer, 2017 ¹⁸	Germany	Physical inactivity ^e	47.88	-	-	685.84	-	-
Ding, 2016 ¹⁹	Canada	Physical inactivity ^f	35.93	6.92	42.85	514.58	99.09	613.67
Ding, 2016 ¹⁹	United States	Physical inactivity ^f	104.37	12.91	117.28	1,494.82	184.89	1,679.71
Ding, 2016 ¹⁹	France	Physical inactivity ^f	21.16	7.13	28.29	303.04	102.09	405.13
Ding, 2016 ¹⁹	Germany	Physical inactivity ^f	35.64	9.37	45.01	510.48	134.23	644.70

First author, year/ Organization, year	Country/ region	Risk factor definition	Direct healthcare costs per capita in country/ region of origin (CAD)	Indirect costs per capita in country/ region of origin (CAD)	Direct healthcare and indirect costs per capita in country/ region of origin (CAD)	Total estimated direct healthcare costs based on the Ontario population (CAD millions) ^a	Total estimated indirect costs based on the Ontario population (CAD millions) ^a	Total estimated costs based on the Ontario population (CAD millions) ^a
Ding, 2016 ¹⁹	Italy	Physical inactivity ^f	20.27	11.13	31.41	290.34	159.48	449.81
Ding, 2016 ¹⁹	Spain	Physical inactivity ^f	57.82	8.19	66.01	828.18	117.31	945.50
Ding, 2016 ¹⁹	United Kingdom	Physical inactivity ^f	38.63	11.65	50.28	553.27	166.89	720.16
Ding, 2016 ¹⁹	Australia	Physical inactivity ^f	25.47	6.58	32.06	364.84	94.30	459.14
Ding, 2016 ¹⁹	New Zealand	Physical inactivity ^f	32.26	9.32	41.58	462.10	133.50	595.60
Ding, 2016 ¹⁹	Japan	Physical inactivity ^f	43.68	11.42	55.10	625.64	163.55	789.19
Ding, 2016 ¹⁹	South Korea	Physical inactivity ^f	22.01	6.25	28.26	315.27	89.54	404.81
Maresova, 2014 ²⁰	Czech Republic	Physical inactivity ^g	4.91	-	-	70.33	-	-
Mattli, 2018 ²¹	Switzerland	Physical inactivity ^f	120.91	121.81	242.72	1,731.77	1,744.72	3,476.49
Krueger, 2018 ¹³	British Columbia	Physical inactivity ^c	75.36	145.28	220.64	1,079.35	2,080.88	3,160.23
ISCA/Cebr, 2015 ²²	United Kingdom	Physical inactivity ^f	42.64	273.39	316.03	610.74	3,915.72	4,526.45
ISCA/Cebr, 2015 ²²	Germany	Physical inactivity ^f	29.44	225.53	254.97	421.66	3,230.20	3,651.86
ISCA/Cebr, 2015 ²²	Italy	Physical inactivity ^f	37.09	251.22	288.30	531.17	3,598.13	4,129.30

First author, year/ Organization, year	Country/ region	Risk factor definition	Direct healthcare costs per capita in country/ region of origin (CAD)	Indirect costs per capita in country/ region of origin (CAD)	Direct healthcare and indirect costs per capita in country/ region of origin (CAD)	Total estimated direct healthcare costs based on the Ontario population (CAD millions) ^a	Total estimated indirect costs based on the Ontario population (CAD millions) ^a	Total estimated costs based on the Ontario population (CAD millions) ^a
ISCA/Cebr, 2015 ²²	France	Physical inactivity ^f	26.25	178.31	204.56	375.93	2,553.87	2,929.81
ISCA/Cebr, 2015 ²²	Spain	Physical inactivity ^f	29.88	169.27	199.15	427.95	2,424.47	2,852.41
ISCA/Cebr, 2015 ²²	Poland	Physical inactivity ^f	8.11	72.43	80.54	116.21	1,037.36	1,153.57
Auckland Council, Waikato Regional Council, Wellington Regional Strategy Committee, 2013 ²³	New Zealand	Physical inactivity ⁱ	119.77	128.94	248.71	1,715.42	1,846.73	3,562.15
Ekwaru, 2016 ²⁴	Canada	Inadequate vegetable and fruit consumption ^j	29.48	67.20	96.69	422.28	962.55	1,384.83
Krueger, 2017 ⁵	Canada	Inadequate vegetable and fruit consumption ^j	45.50	90.68	136.18	651.64	1,298.84	1,950.48
Krueger, 2018 ¹³	British Columbia	Inadequate vegetable and fruit consumption ^j	47.25	88.50	135.74	676.69	1,267.50	1,944.19
Lieffers, 2018 ²⁵	Canada	Intake of protective	154.18	259.49	413.67	2,208.24	3,716.68	5,924.92

First author, year/ Organization, year	Country/ region	Risk factor definition	Direct healthcare costs per capita in country/ region of origin (CAD)	Indirect costs per capita in country/ region of origin (CAD)	Direct healthcare and indirect costs per capita in country/ region of origin (CAD)	Total estimated direct healthcare costs based on the Ontario population (CAD millions) ^a	Total estimated indirect costs based on the Ontario population (CAD millions) ^a	Total estimated costs based on the Ontario population (CAD millions) ^a
		and harmful foods ^k						
Nshimyumukiza, 2018 ²⁶	Canada	Diet quality ^l	119.92	254.19	374.11	1,717.62	3,640.73	5,358.35

ISCA/Cebr: International Sport and Culture Association/Centre for Economics and Business Research

Notes: a. Derived by taking the cost per capita (in 2018 CAD) in the country/region where the costing occurred and multiplying it by the population of Ontario in 2018 (n=14,322,757)⁴; b. Defined as binge drinking, heavy drinking, alcohol consumption by youth and pregnant women; c. Defined as leisure energy expenditure of less than 1.5 cal/kg/day; d. Defined as survey respondents who reported no physical exercise at all, physical exercise now and then, and physical exercise at least once a week; e. Defined as survey respondents who were never active; f. Defined as not meeting the World Health Organization recommendations of 150 minutes of moderate physical activity per week or 75 minutes of high intensity physical activity per week; g. Defined as survey respondents who were inactive (no physical activity) or insufficiently active (less than 75 min of vigorous activity a week or 150 min of moderate activity a week or 180 min of walking a week or any combination resulting in less than 600 MET min a week on at least 3 days per week); i. Defined as not meeting New Zealand Physical Activity Guidelines of 30 min of moderate-intensity physical activity 5 days per week; j. Defined as not meeting the sex- and age-specific recommended number of daily servings as per Canada's Food Guide; k. Protective foods defined as vegetables, fruit, whole grains, milk, nuts and seeds and harmful foods defined as processed meat, red meat and sugar-sweetened beverages; l. Defined by the Healthy Eating Index-Canada-2010

Table 3:
Supplementary information on studies included in the estimation of direct health care costs and productivity losses (indirect costs) due to four risk factors: tobacco smoking, alcohol consumption, physical inactivity and unhealthy eating

Risk factor	First author, year/ Organization, year	Country/ region	Direct health care costs included	Indirect costs included
Tobacco smoking	Krueger, 2017 ⁵	Canada	Hospital care, physician services, other health care professionals (excluding dental services), drugs, health research, and other health care expenditures	Productivity losses due to short- and long-term disability and premature mortality
Tobacco smoking	Cher, 2017 ⁶	Singapore	Hospital care	Productivity losses from illness (absenteeism), smoking breaks (presenteeism) and the cost of premature mortality
Tobacco smoking	Fosson, 2014 ⁷	Alabama	Not examined in study	Productivity losses due to premature death and smoking-attributable illness
Tobacco smoking	Ginsberg, 2014 ⁸	Israel	Hospital care, medications, ambulatory care, emergency room visits, out-patient visits, nursing home care and rehabilitation	Productivity losses due to absenteeism
Tobacco smoking	Max, 2016 ⁹	California	Hospital care, ambulatory care, prescriptions, home health care and nursing home care	Productivity losses due to illness and premature death attributable to smoking
Tobacco smoking	Tsalapati, 2014 ¹⁰	Greece	Hospital treatment costs and hospital employee salaries	Not examined in study
Tobacco smoking	Canadian Substance Use Costs and Harms Scientific Working Group, 2018 ¹¹	Ontario	Inpatient hospitalizations, day surgery treatment episodes, emergency department	Productivity losses due to premature mortality, long-term disability, and absenteeism and presenteeism

Risk factor	First author, year/ Organization, year	Country/ region	Direct health care costs included	Indirect costs included
			presentations, specialist treatment for substance use disorders, the costs of physician's time and prescription drug costs	
Tobacco smoking	Dobrescu, 2017 ¹²	Canada	Hospital care, prescription drugs, physician care, and fire-attributable direct health care costs	Productivity losses due to short- and long-term disability and premature mortality
Tobacco smoking	Krueger, 2018 ¹³	British Columbia	Hospital care, physician care and medications	Productivity losses due to short- and long-term disability and premature mortality
Alcohol consumption	Krueger, 2017 ⁵	Canada	Hospital care, physician services, other health care professionals (excluding dental services), drugs, health research, and other health care expenditures	Productivity losses due to short- and long-term disability and premature mortality
Alcohol consumption	Kopp, 2017 ¹⁴	France	Public expenditures on care	Values of life and production losses due to death and values of loss in quality of life due to disease
Alcohol consumption	Sacks, 2015 ¹⁵	United States	Health care costs (specialty care for abuse/dependence, hospitalization, ambulatory care, nursing home, drugs/services, fetal alcohol syndrome, prevention/research, training, health insurance administration)	Lost productivity (impaired productivity at work and home, absenteeism, impaired productivity while in speciality care and hospital, mortality, incarceration of perpetrators, crime victims, fetal alcohol syndrome)
Alcohol consumption	Verhaeghe, 2017 ¹⁶	Belgium	Inpatient and outpatient care, pharmaceuticals, and prevention	Productivity losses due to disability and premature mortality
Alcohol consumption	Canadian Substance Use Costs and Harms	Ontario	Inpatient hospitalizations, day surgery treatment episodes, emergency	Productivity losses due to premature mortality, long- term disability, and

Risk factor	First author, year/ Organization, year	Country/ region	Direct health care costs included	Indirect costs included
	Scientific Working Group, 2018 ¹¹		department presentations, specialist treatment for substance use disorders, the costs of physician's time and prescription drug costs	absenteeism and presenteeism
Alcohol consumption	Krueger, 2018 ¹³	British Columbia	Hospital care, physician care and medications	Productivity losses due to short- and long-term disability and premature mortality
Physical inactivity	Krueger, 2017 ⁵	Canada	Hospital care, physician services, other health care professionals (excluding dental services), drugs, health research, and other health care expenditures	Productivity losses due to short- and long-term disability and premature mortality
Physical inactivity	Bolin, 2018 ¹⁷	Sweden	Hospital-based inpatient and outpatient care and primary care	Productivity losses due to mortality and disability
Physical inactivity	Dallmeyer, 2017 ¹⁸	Germany	Curative treatment, prevention, rehabilitation, continuing caring	Not examined in study
Physical inactivity	Ding, 2016 ¹⁹	Global	Health care costs	Productivity losses due to premature mortality
Physical inactivity	Maresova, 2014 ²⁰	Czech Republic	Health care costs	Not examined in study
Physical inactivity	Mattli, 2018 ²¹	Switzerland	Inpatient and outpatient services and drugs	Productivity losses due to disability and premature mortality
Physical inactivity	Krueger, 2018 ¹³	British Columbia	Hospital care, physician care and medications	Productivity losses due to short- and long-term disability and premature mortality
Physical inactivity	ISCA/Cebr, 2015 ²²	Europe	Primary care, outpatient care, accident and emergency, inpatient care and pharmaceutical costs	Productivity losses due to morbidity and premature mortality
Physical inactivity	Auckland Council, Waikato Regional Council, Wellington	New Zealand	Costs of hospital stays, pharmaceutical products and medicine,	Human cost of the injury (disability and disruption to a normal functioning life), loss

Risk factor	First author, year/ Organization, year	Country/ region	Direct health care costs included	Indirect costs included
	Regional Strategy Committee, 2013 ²³		outpatient services, other specific costs identified (e.g., ambulance, transport costs), general practitioner and primary health care service (including psychiatrist and counselling), medical research into prevalence/treatment, health promotion, screening programmes	of potential earnings to the patient and loss of productivity to the economy/society, and cost of premature death
Unhealthy eating	Ekwaru, 2016 ²⁴	Canada	Hospital care, physician services and drugs	Productivity losses due to illness, disability and premature death
Unhealthy eating	Krueger, 2017 ⁵	Canada	Hospital care, physician services, other health care professionals (excluding dental services), drugs, health research, and other health care expenditures	Productivity losses due to short- and long-term disability and premature mortality
Unhealthy eating	Krueger, 2018 ¹³	British Columbia	Hospital care, physician care and medications	Productivity losses due to short- and long-term disability and premature mortality
Unhealthy eating	Lieffers, 2018 ²⁵	Canada	Hospital care, physician services and drugs	Productivity losses due to short- and long-term disability and premature mortality
Unhealthy eating	Nshimyumukiza, 2018 ²⁶	Canada	Hospital care, physician services and drugs	Productivity losses due to short- and long-term disability and premature mortality

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