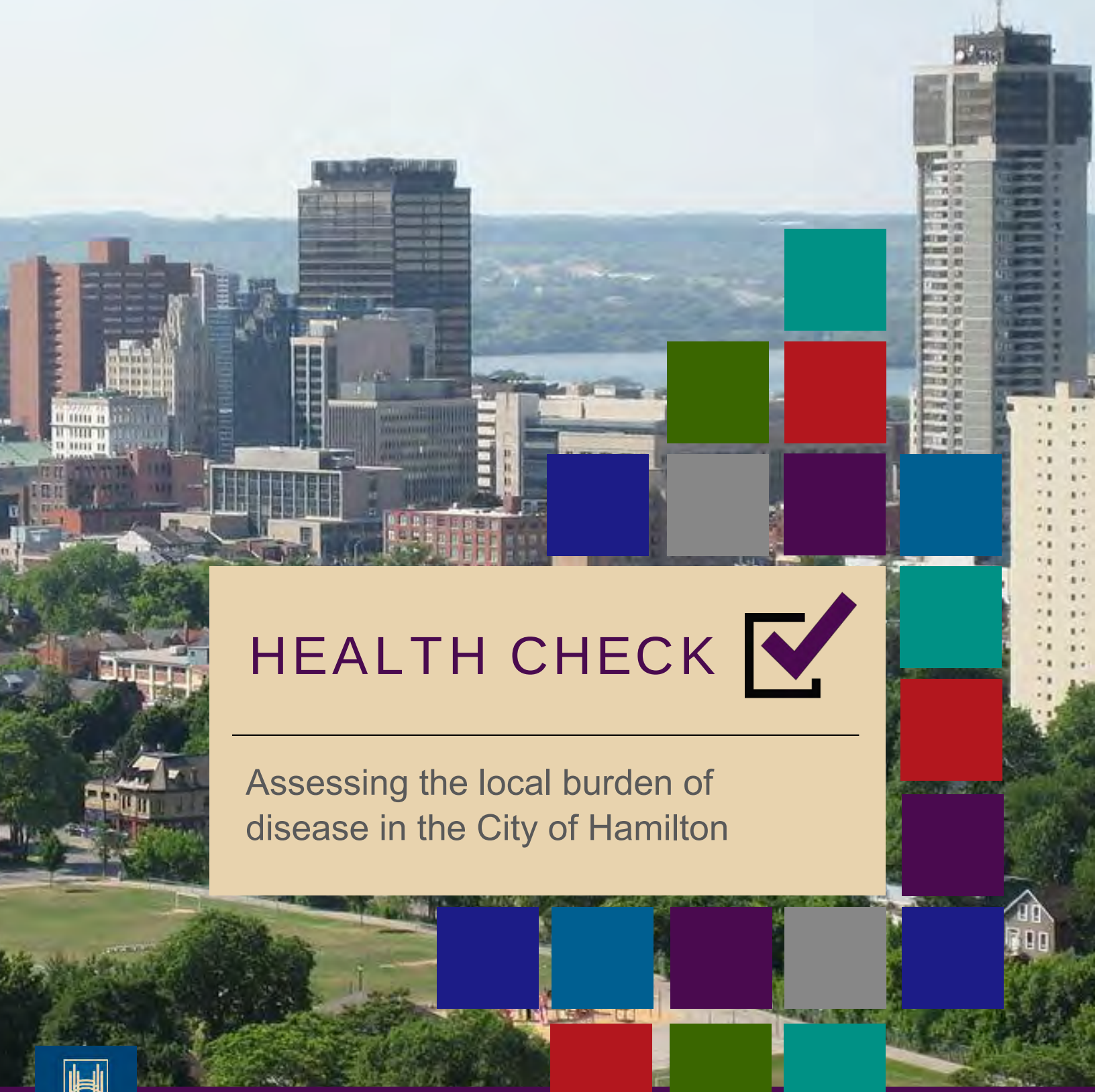

HEALTH CHECK

Assessing the local burden of disease in the City of Hamilton

Epidemiology and Evaluation
Healthy and Safe Communities
City of Hamilton

July 2018 • 2nd Edition

epiandeval@hamilton.ca

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Assessing the local burden of disease in the City of Hamilton

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Epidemiology & Evaluation
Epidemiology, Wellness, and Communicable Disease Control
Healthy and Safe Communities
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Health Check

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PROCESS

38 Health outcomes selected that align with public health mandate

4 Criteria developed and used to quantify and prioritize health outcome measures

#1 - Does it impact many people?

- **Key Finding: Injuries are common; they cause 52,000 emergency department visits annually in Hamilton**

#2 - Does it have severe health consequences?

- **Key Finding: Most preventable deaths caused by chronic disease and cancer; over 1,800 of these deaths could be avoided annually in Hamilton**

#3 - Is it uniquely problematic in our community?

- **Key Finding: Lung cancer morbidity and mortality rates significantly greater in Hamilton compared to Ontario**

#4 - Is it getting worse in our community?

- **Key Finding: The increasing morbidity and mortality trends of unintentional poisoning are driven by opioid overdoses**

TOP 3 MOST BURDENING HEALTH OUTCOMES

OUTCOME	BURDEN	CAUSES	POPULATION
Lung Cancer			
	472 new cases & 334 deaths per year Higher than Ontario Increasing morbidity	80-85% tobacco smoke 10-15% radon gas <5% air pollution	Smoking higher among urban indigenous (87%), low income (25%), and lone parents (29%). Higher smoking rates in lower Hamilton.
Unintentional Poisoning			
	1,547 ED visits & 30+ deaths per year Higher than Ontario Increasing mortality	72% illicit or prescribed drugs 25% chemicals & gases 3% alcohol	80% of opioid deaths are working-age males Drug use higher in lower Hamilton, and among low income, homeless, & urban indigenous.
Chronic Obstructive Pulmonary Disease			
	1,356 hospitalizations & 163 deaths per year Higher than Ontario Increasing morbidity	55% tobacco smoke 15% air pollution & tobacco smoke 7% air pollution	Smoking higher among urban indigenous (87%), low income (25%), and lone parents (29%). Higher smoking rates and air pollution in lower Hamilton.

Introduction

Public health professionals and decision-makers are responsible for ensuring that limited health resources are utilized to have the greatest impact on population health[1]. This requires identifying the relative importance of illness and disease ("health outcomes") within local populations. The relative human loss and economic costs associated with health outcomes are described as the burden of disease[2]. Assessing the burden of disease in populations is a key goal of public health epidemiology[3] and a requirement of the Ontario Public Health Standards[1].

Burden of disease has multiple meanings and can be measured in a variety of ways[2]. Multiple measures of population health can be used to balance the quantity versus quality of human life that is impacted by health outcomes. The various types of population health measures used in this assessment include:

- **Morbidity** – individuals with a disease, illness, or disability.
- **Mortality** – any death (whether premature or not) resulting from a health outcome.
- **Potential Years of Life Lost** – severity measure of premature death (difference between years lived and expected duration of life).
- **Relative comparison** – identify unique local health issues by comparing health outcome measures between populations (local population versus regional population).
- **Trends** – identify changes in population health measures over time.

In addition to describing health status, these population health measures can be used to systematically prioritize the burden of disease in a local population. Hence, the objective of this assessment is to quantify and prioritize the burden of disease for the City of Hamilton. It is expected that this assessment will inform a broader priority setting exercise that considers population health assessment to understand local context as one component of evidence-informed decision making. Other factors to consider include effectiveness of public health interventions, regulatory/ mandated priorities, community and political preferences, and available resources.

NCCMT: http://www.nccmt.ca/about/eiph

Methods

Hamilton Public Health Prioritization Tool

A consistent and standardized approach to assessing the burden of health outcomes is an important input into public health decision-making and planning. A system for integrating, analyzing, and disseminating priorities based on population health assessment is needed to understand the comparative importance of health outcomes in our community.

The Hamilton Public Health Prioritization Tool was developed as a pilot project to prioritize the burden of health outcomes in the City of Hamilton. Using a rational approach to priority setting, this tool applies a multi-criteria decision analysis to population health measures. This method is consistent with the methods recommended by the National Collaborating Centre for Methods and Tools[4] and the National Association of County and City Health Officials[5] multi-criteria decision analysis and prioritization matrices.

The priority assessment criteria were developed by a workgroup consisting of members of Hamilton's Epidemiology and Evaluation program. Giving consideration to data availability and the feasibility of data analysis, the workgroup determined the following:

- **Burden criteria:** What factors should be considered when determining priorities?
- **Weighting of criteria:** Which criteria are more important for defining burden?
- **Measures required to assess criteria:** What summary measures best represent the intention of the criteria?
- **Thresholds for defining the score:** How will each criterion be assessed?

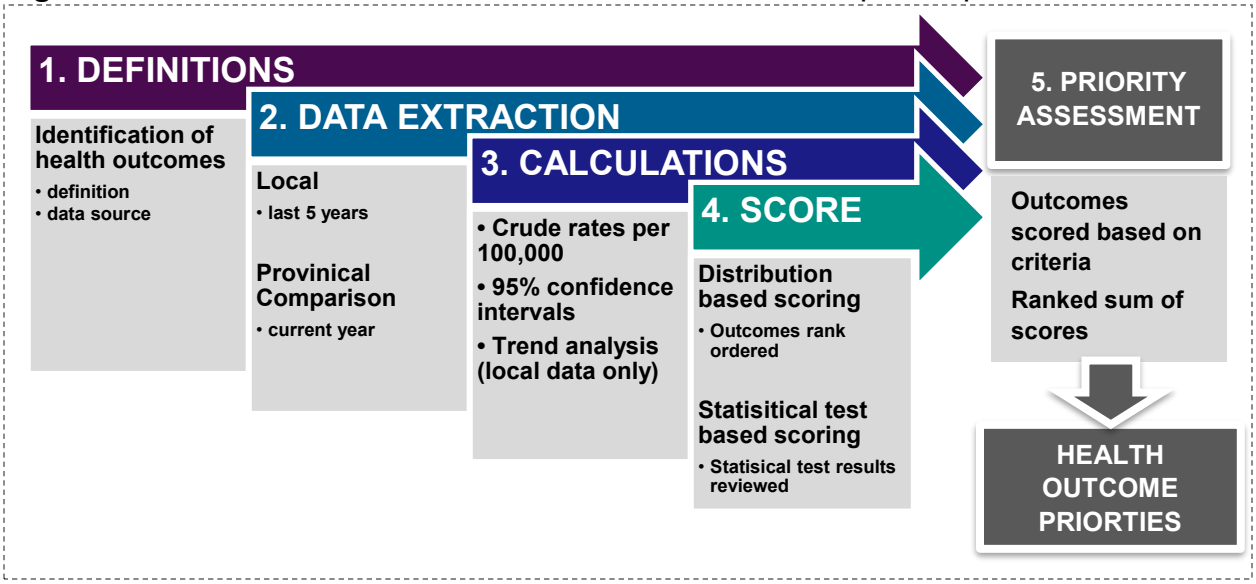
The completed Hamilton Public Health Prioritization Tool, as determined by the workgroup, is shown in **Table 1** and the process used to complete the prioritization tool is summarized in **Figure 1**.

In addition to quantifying the burden of disease, it is also important to determine the drivers of disease, which are referred to as risk factors. Canadian population attributable risk (PAR) estimates from the Institute for Health Metrics and Evaluation[16] (Global Burden of Disease results tool) were used to estimate the proportion of local mortalities attributed to risk factors. Gaps in PAR estimates for health outcomes were supplemented with estimates from peer-reviewed literature. Mortalities were summed for each risk factor and ranked based on total attributed mortalities.

Table 1. Summary of the priority assessment criteria and population health measures used in the Hamilton Public Health Prioritization Tool.

Criteria (weighting)	Population Health Measures	Score
Does it impact many people? (27.3%)	Consider one of the following measures for this criteria: • Incidence rate • Emergency department visit rate • Hospitalization rate	**Morbidity:** **3** Impacts many people (top 30% of non-zero rates) **2** Impacts some people (middle 40% of non-zero rates) **1** Impacts few people (bottom 30% of non-zero rates) **0** Impacts no people (all zero rates)
Does the health outcome have severe health consequences? (36.4%)	Consider all of the following measures for this criteria: • Mortality rate • Potential years of life lost (PYLL)	**Mortality:** **2** Very severe/serious (top 30% of rates) **1** Severe/serious (middle 40% of rates) **0** Not severe/serious (bottom 30% of rates)
		PYLL: **2** Very severe/serious (top 30% of rates) **1** Severe/serious (middle 40% of rates) **0** Not severe/serious (bottom 30% of rates)
Is the health outcome uniquely problematic in our community? (18.2%)	Consider the following measure for this criteria: • Comparison to equivalent Ontario measure (statistical testing was used to determine whether rates were higher or lower than Ontario).	**Morbidity**: **1** Higher than Ontario **0** Similar to Ontario **-1** Lower than Ontario
		Mortality: **1** Higher than Ontario **0** Similar to Ontario **-1** Lower than Ontario
Is the health outcome getting worse in our community? (18.2%)	Consider the following measure for this criteria: • Trend over most current 5 year period (regression analysis was used to determine whether trends changed significantly).	**Morbidity**: **1** Getting worse **0** Staying the same **-1** Getting better
		Mortality: **1** Getting worse **0** Staying the same **-1** Getting better

Figure 1: The Hamilton Public Health Prioritization Tool completion process



Health Outcome Categories

Health outcome categories were selected to be semi-specific (e.g., lung cancer) as opposed to broad topics (e.g., cancer). This was done to avoid bias by compounding diseases into broad topics. Categories were then selected from existing categorizations developed by the Association of Public Health Epidemiologists in Ontario and supplemented as needed. These categories align with the public health areas mandated in the Ontario Public Health Standards[1] and most of these health outcomes are considered fully or partially preventable. The 38 health outcome categories are listed below (refer to **Appendix A** for full definitions).

- Female breast cancer
- Lung cancer
- Malignant melanoma
- Oral cancer
- Prostate cancer
- Cervical cancer
- Colorectal cancer
- Ischemic heart disease
- Cerebrovascular disease
- Hypertensive disease
- Chronic obstructive pulmonary disease
- Asthma
- Diabetes
- Kidney disease
- Enteric, Food and Waterborne Diseases
- Respiratory or direct contact diseases
- Sexually transmitted and blood-borne infections
- Vector borne and zoonotic diseases
- Substance use related disorders
- Schizophrenia, delusional and non-organic psychotic disorders
- Mood/affective disorders
- Anxiety disorders
- Selected disorders of adult personality and behaviour
- Oral health
- Weather-related illness/injury
- Assault
- Self-harm
- Burns
- Cut/pierce
- Falls
- Near-drowning/submersion
- Neurotrauma
- Struck by or against
- Transport-related injuries
- Unintentional poisoning
- Overexertion
- Fetal health
- Infant health

Data Sources

Unless otherwise specified, the data used throughout this assessment were retrieved from the data sources in **Table 2** (see **Appendix B** for detailed notes on data sources).

Table 2. Data sources for morbidity and mortality data for City of Hamilton and Ontario.

Type of Measure	Data Source
Incidence (infectious diseases)	Integrated Public Health Information System (iPHIS) database, Ontario Ministry of Health and Long-Term Care, extracted from PHO infectious Disease Query.
Incidence (cancer)	Cancer Care Ontario - SEER*Stat Release 10 -OCRIS (August 2015) released November 2015
Incidence (reproductive health)	Public Health Unit Analytic Reporting Tool (Standard Reports), BORN Information System, BORN Ontario.
Emergency department visits	Ambulatory visit (NACRS), Ministry of Health and Long-term care, IntelliHEALTH ONTARIO
Hospitalizations	Inpatient discharges (DAD), Ministry of Health and Long-term care, IntelliHEALTH ONTARIO.
Mental Health Hospitalizations	IP Adult MH Assessment, Treatment, Diagnosis (OMHRS), Ministry of Health and Long-term care, IntelliHEALTH ONTARIO.
Mortality & PYLL	Vital Stats Death, Ministry of Health and Long-term care, IntelliHEALTH ONTARIO

Limitations

Inclusions

Results produced by this tool are limited by the current availability of local data. Health conditions for which no measurement is available (i.e. data gaps) are excluded from the prioritization results. As such, conditions where no local data exists for all the identified priority criteria can never be identified as a priority (e.g. hospital acquired infections).

This product is limited in scope to population health assessment of health outcomes for the entire population of the City of Hamilton and does not consider smaller subgroups of people. Smaller population subgroups such as children, seniors, low income families, or certain neighbourhoods, for example, may have different health outcome priorities.

Due to the feasibility of completion, this product does not consider other factors such as prevalence of risk factors, analysis of health inequities, impact or feasibility of interventions, or economic and social costs. Future versions of this tool may expand to consider some of these factors. In particular, the Epidemiology and Evaluation workgroup identified health inequities as an important consideration for priority setting but chose not to pursue internal local data analysis at this time as there is a collaborative project currently underway examining health inequity locally. Future priority setting could include consideration of this criteria based on the outputs of this project.

Standard definitions of health outcomes were chosen when available but it should be noted that the inclusions and combinations of the health outcome categorization could influence the outcomes of the prioritization tool (i.e. broader definitions score higher compared to narrow categories).

Measurement

Results produced by this tool are limited by the quality of local data and comparison of different data sources with different methods of data collection and reporting.
When assessing the criteria “Does it impact many people”, multiple measures from various sources were included in the tool. The rank distribution for this criteria considers incidence rate, emergency department visit rates, and hospital discharges alongside one another although it is recognized that these do not measure the exact same thing. Healthcare utilization data as proxy for incidence may underestimate the actual magnitude of health outcomes in populations (e.g. as not all people seek professional care for many health conditions), although it does provide weight to outcomes that burden the healthcare system.

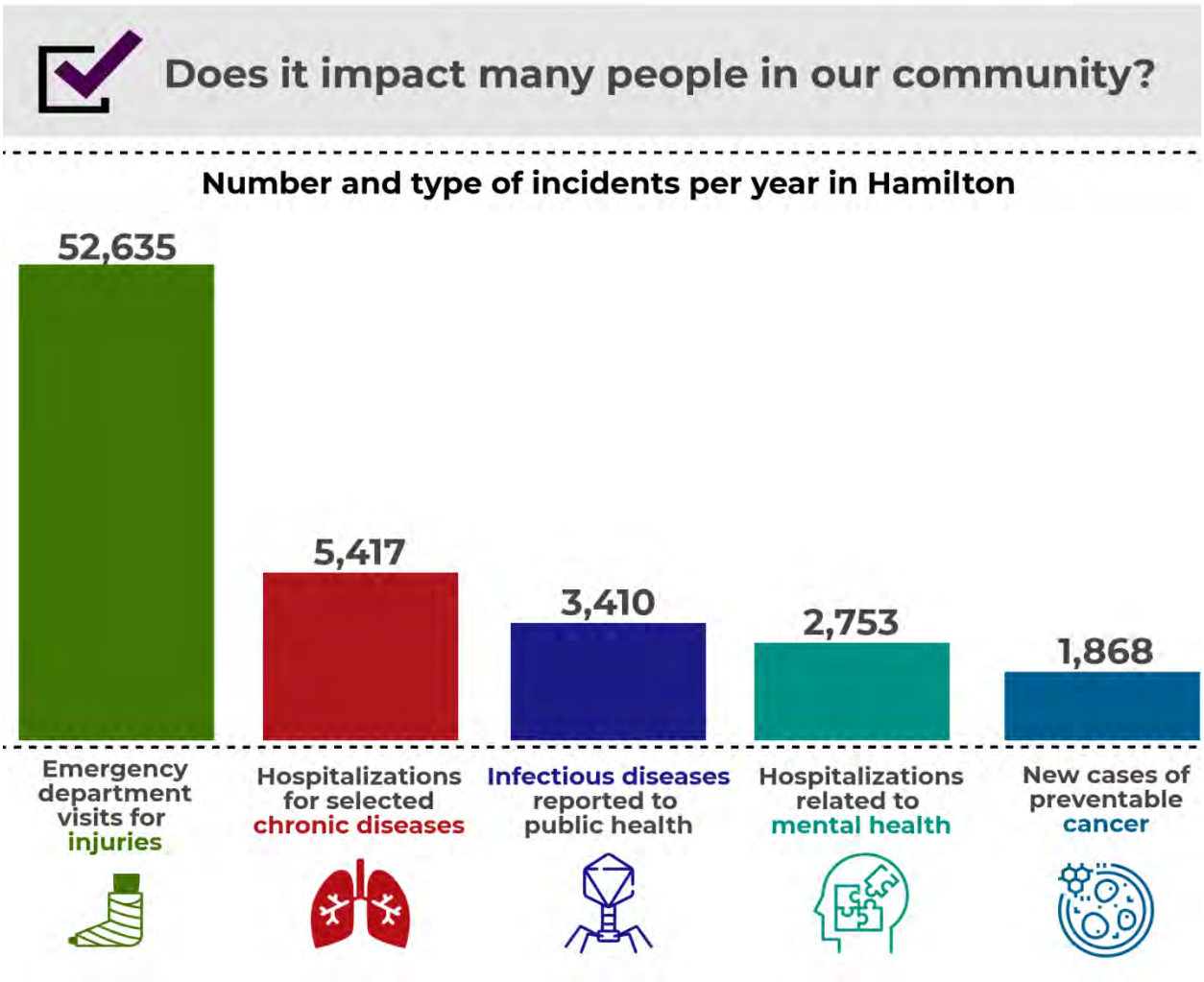
The statistical tests used in the Hamilton Public Health Prioritization Tool provide a crude assessment of the criteria and may over or underestimate the results. Using a simple linear regression for the assessment of trend will identify conditions with consistent incremental increases or decreases over time but does not consider the magnitude of the change (i.e. it could be a small or large change or time). Advanced assessment of the trend and/or variation in the data over time was not completed at this time.

The Epidemiology and Evaluation workgroup also identified that there may be more appropriate measures available to assess the severity or seriousness of a health outcome including case fatality and disability-adjusted years of life lost but chose not to pursue this due to feasibility concerns. Future priority setting could include consideration of these measures.

Burden of Disease

Does it impact many people?

It can be challenging to measure the number of people impacted by a health outcome. New cases of cancer, reportable infectious diseases, and birth outcomes are routinely captured in surveillance databases. For other health outcomes, such as injury, chronic disease, and mental health, interactions with the healthcare system are used as an indicator to quantify the commonality of a health outcome. There are certain limitations associated with this approach, including under-reporting, but it does cause systematic weighting towards conditions that burden the healthcare system and thereby factors in an opportunistic layer of resource utilization.



The number and rates of morbidities for the selected health outcomes are reported in ranked order in **Table 3** for the City of Hamilton (table located at the end of this section). Although morbidities for fetal and infant health are relatively moderate, these health outcomes had the highest rates as it impacts a small sub-population in Hamilton.

Injuries were the most common health outcome among Hamiltonians by a wide margin. In 2017, there were over 52,000 emergency department (ED) visits for injuries in Hamilton which indicates a larger burden on the healthcare system. Over 40% of injury-related ED visits were due to fall injuries (totalling over 21,000 ED visits per year).

Another notable health outcome was ischemic heart disease which had the highest hospitalization rate (1,726 hospitalizations in 2017). Sexually transmitted and bloodborne infections had one of the highest incidence rates with 2,324 cases reported in 2017.

Vector-borne and zoonotic disease was the most uncommon health outcome among Hamiltonians; there were 19 cases reported to public health in 2017. In other words, for every 1 case of vector-borne and zoonotic disease reported, there are 1,125 ED visits for injuries resulting from a fall.

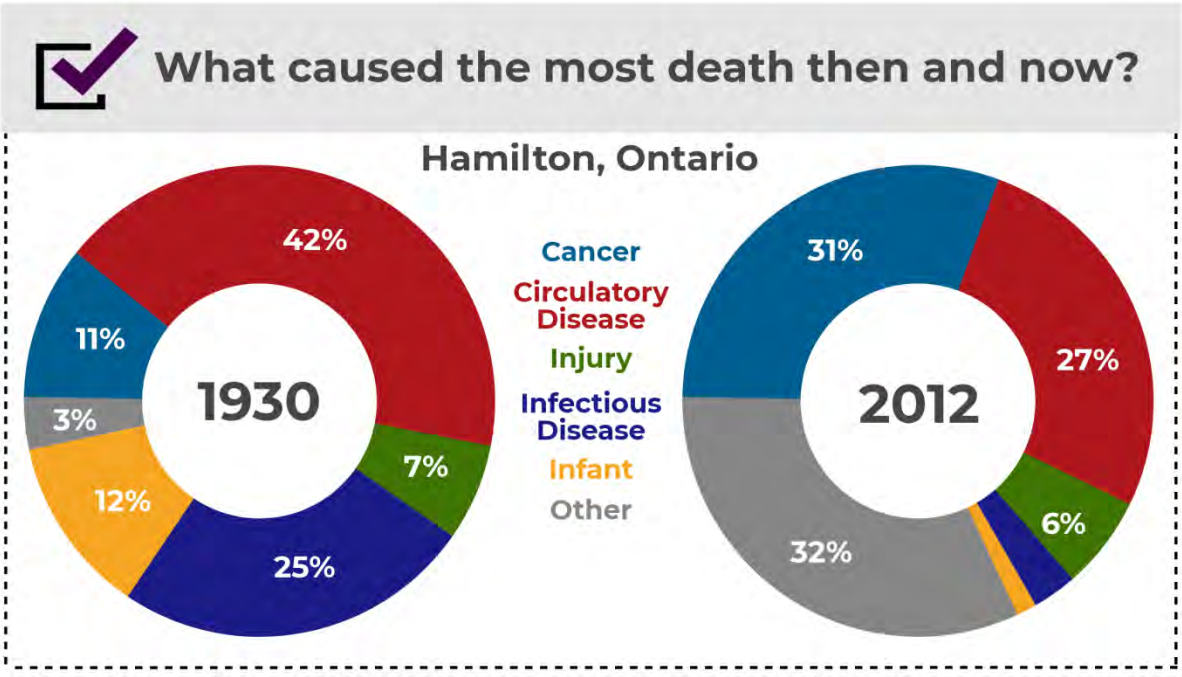
Table 3. Morbidity rates for health outcomes, City of Hamilton.

Health Outcome	Type of Measure	Year	Morbidity Counts	Morbidity Rate (per 100,00)
Fetal health	Incidence	2017	397	6,893.56
Infant health	Incidence	2017	312	5,417.61
Falls	ED visit rate	2017	21,374	3,750.43
Struck by or against	ED visit rate	2017	9,830	1,724.84
Cut/pierce	ED visit rate	2017	5,779	1,014.02
Overexertion	ED visit rate	2017	4,388	769.95
Transport-related injuries	ED visit rate	2017	3,996	701.17
Sexually transmitted and blood-borne infect.	Incidence	2017	2,324	407.79
Neurotrauma	ED visit rate	2017	2,163	379.54
Assault	ED visit rate	2017	1,920	336.90
Ischemic heart disease	Hospitalization	2017	1,726	302.86
Unintentional poisoning	ED visit rate	2017	1,547	271.45
Oral health	ED visit rate	2017	1,451	254.60
Chronic obstructive pulmonary disease	Hospitalization	2017	1,356	237.93
Mood/affective disorders	Hospitalization	2015	1,097	197.66
Cerebrovascular disease	Hospitalization	2017	901	158.10
Self-harm	ED visit rate	2017	857	150.38
Female breast cancer	Incidence	2012	396	144.17
Respiratory or direct contact diseases	Incidence	2017	792	138.97
Burns	ED visit rate	2017	757	132.83
Schizophrenia, delusional and non-organic psychotic disorders	Hospitalization	2015	731	131.71
Prostate cancer	Incidence	2012	318	119.46
Diabetes	Hospitalization	2017	643	112.83
Lung cancer	Incidence	2012	472	87.27
Colorectal cancer	Incidence	2012	432	79.87
Kidney disease	Hospitalization	2017	418	73.35
Anxiety disorders	Hospitalization	2015	390	70.27
Substance related disorders	Hospitalization	2015	360	64.87
Enteric, Food and Waterborne Diseases	Incidence	2017	275	48.25
Asthma	Hospitalization	2017	220	38.60
Selected disorders of adult personality and behaviour	Hospitalization	2015	175	31.53
Hypertensive disease	Hospitalization	2017	153	26.85
Malignant melanoma	Incidence	2012	129	23.85
Weather related events	ED visit rate	2017	112	19.65
Oral cancer	Incidence	2012	99	18.30
Cervical cancer	Incidence	2012	22	8.01
Near-drowning/submersion	ED visit rate	2017	24	4.21
Vector-borne and zoonotic diseases	Incidence	2017	19	0.00

Does the health outcome have severe health consequences?

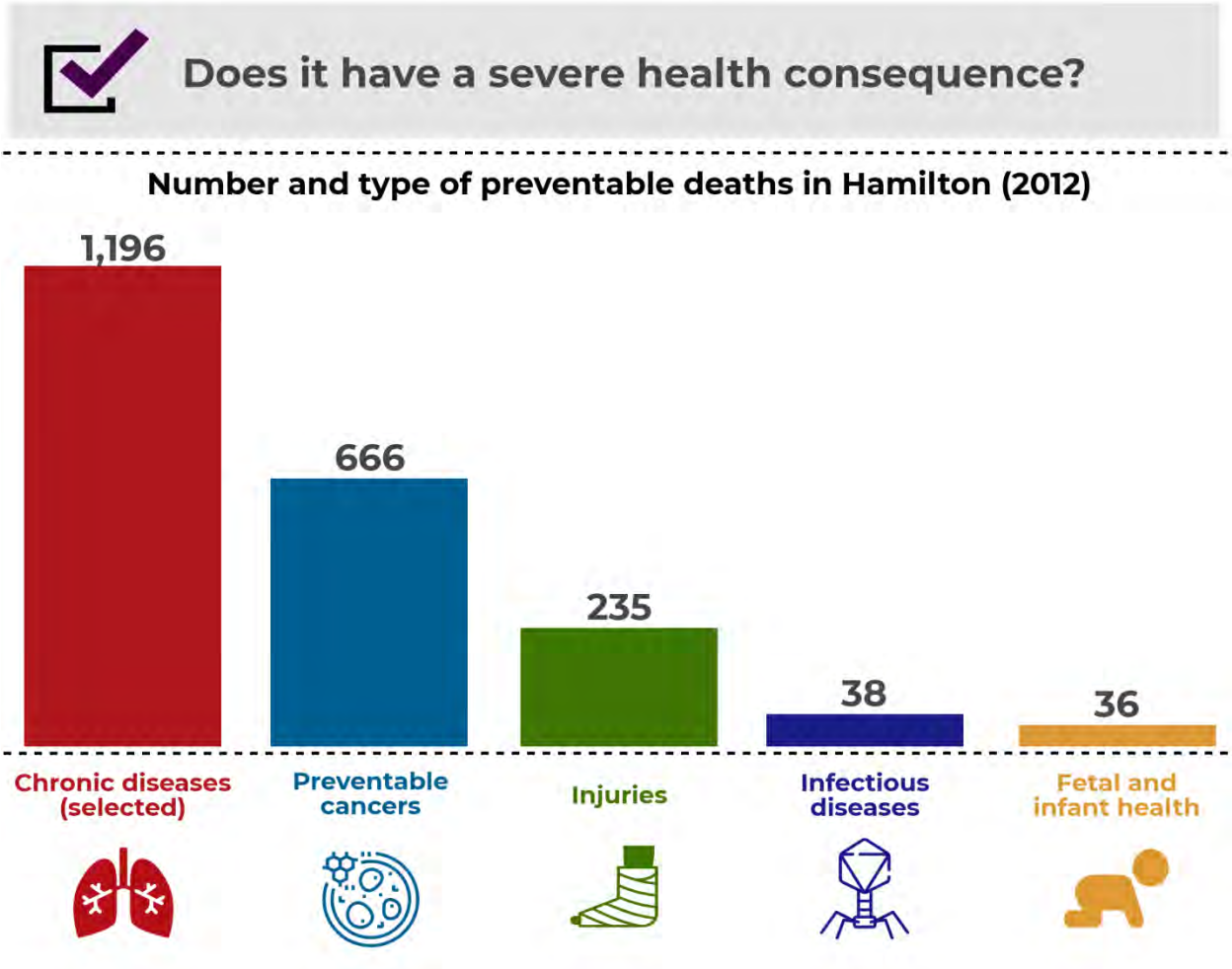
Over 4,100 people die each year in Hamilton and 1 in 3 of these deaths are premature (that is, a person dies before an expected lifespan of 75 years). These premature deaths result in a total of 23,500 potential years of life lost annually. Many of the premature deaths in Hamilton are preventable. Locally, it is estimated that each year there are 700 premature deaths from causes considered to be preventable (e.g., vaccine-preventable diseases, traffic collisions, lung cancer).

Examination of historical data for Hamilton shows that circulatory disease was the leading cause of death in 1930, but infectious diseases also contributed to a quarter of all deaths and nearly 1 in 8 deaths occurred during early infancy. Today, cancer is the leading cause of death in Hamilton followed closely by circulatory disease. Together these two causes account for over half of all deaths in Hamilton (it is important to note that this data encompasses all mortalities, whether preventable or not). Other causes of death are largely attributed to diseases of the respiratory system (e.g., COPD, asthma), nutritional and metabolic diseases (e.g., diabetes), and mental or behavioural disorders (e.g., dementia).



The number and rates of mortalities for the selected health outcomes are reported in ranked order in **Table 4** for the City of Hamilton, 2012 (table located at the end of this section). Similar to local morbidity data, fetal and infant mortalities had the highest rates due to a moderate number of deaths among a very small sub-population. The greatest number of deaths was due to ischemic heart disease, followed by lung cancer, cerebrovascular disease, and chronic obstructive pulmonary disease. No deaths were recorded for oral health conditions, burns, neurotrauma, overexertion, anxiety disorders, or personality/behavioural disorders.

When looking at broader health categories, most preventable deaths were due to chronic disease, followed by preventable cancer and injury (it is important to note that this data focuses on all premature and non-premature preventable mortalities as opposed to all mortalities which were discussed previously).



Hamiltonians have an expected lifespan of 75 years. Death before this age is considered premature. The difference between the age of a premature death and the expected lifespan of 75 years translates to the potential years of life lost due to a health outcome. The potential years of life lost can be summed for all deaths to get a population total. Health outcomes that primarily affect younger populations usually have a higher population total of potential years of life lost.

The number and rates of potential years of life lost for the selected health outcomes are reported in ranked order in **Table 5** for the City of Hamilton, 2012 (table located at the end of this section). Ischemic heart disease had the highest potential years of life lost (totalling 2,512 years lost in 2012), Hamiltonians who died prematurely from ischemic heart disease had the potential to live another 11 years if they were healthy. Infant health had the next highest potential years of life lost totalling 1,873 years; although there are fewer deaths associated with this health outcome, all deaths are considered premature and each death lost an entire lifespan of 75 years. Similarly, almost all deaths associated with self-harm and unintentional poisoning are premature and result in an average of 30-34 years of life lost per person.

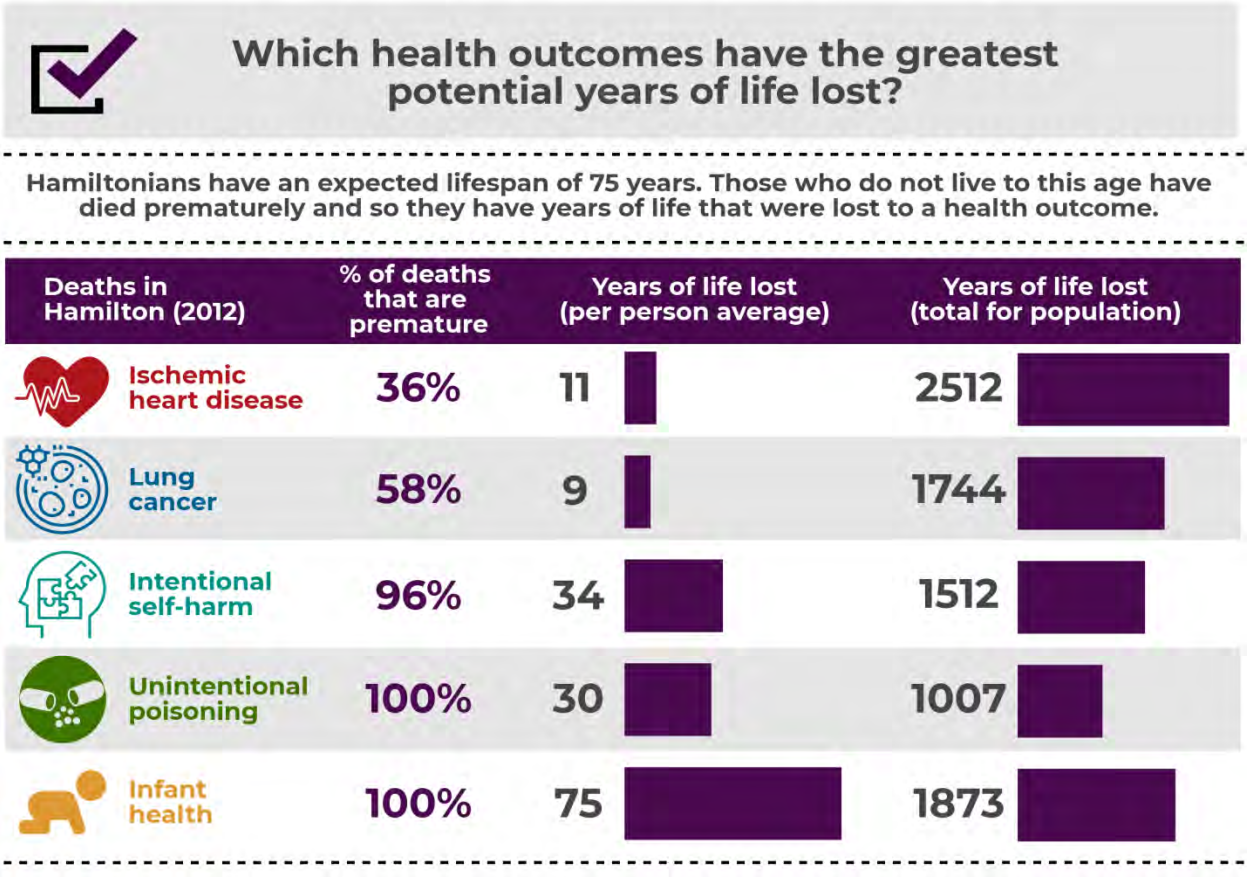


Table 4. Mortality rates for health outcomes, City of Hamilton (2012).

Health Outcome	Mortality Count	Mortality Rate (per 100,000)
Infant health	25	459.81
Fetal health	11	201.02
Ischemic heart disease	616	113.89
Lung cancer	334	61.75
Cerebrovascular disease	189	34.94
Female breast cancer	89	32.40
Chronic obstructive pulmonary disease	163	30.14
Prostate cancer	73	27.42
Diabetes	144	26.62
Colorectal cancer	128	23.67
Falls	119	22.00
Self-harm	47	8.69
Kidney disease	40	7.40
Hypertensive disease	39	7.21
Unintentional poisoning	34	6.29
Transport-related injuries	24	4.44
Substance related disorders	20	3.70
Malignant melanoma	18	3.33
Oral cancer	18	3.33
Sexually transmitted and blood-borne infections	16	2.96
Cervical cancer	6	2.18
Respiratory or direct contact diseases	11	2.03
Enteric, Food and Waterborne Diseases	10	1.85
Asthma	5	0.92
Assault	4	0.74
Near-drowning/submersion	4	0.74
Weather related events (including heat, cold, other)	2	0.37
Struck by or against	2	0.37
Schizophrenia, delusional and non-organic psychotic disorders	2	0.37
Mood/affective disorders	2	0.37
Vector borne and zoonotic diseases	1	0.18
Cut/pierce	1	0.18
Oral health	0	0.00
Burns	0	0.00
Neurotrauma	0	0.00
Overexertion	0	0.00
Anxiety disorders	0	0.00
Selected disorders of adult personality and behaviour	0	0.00

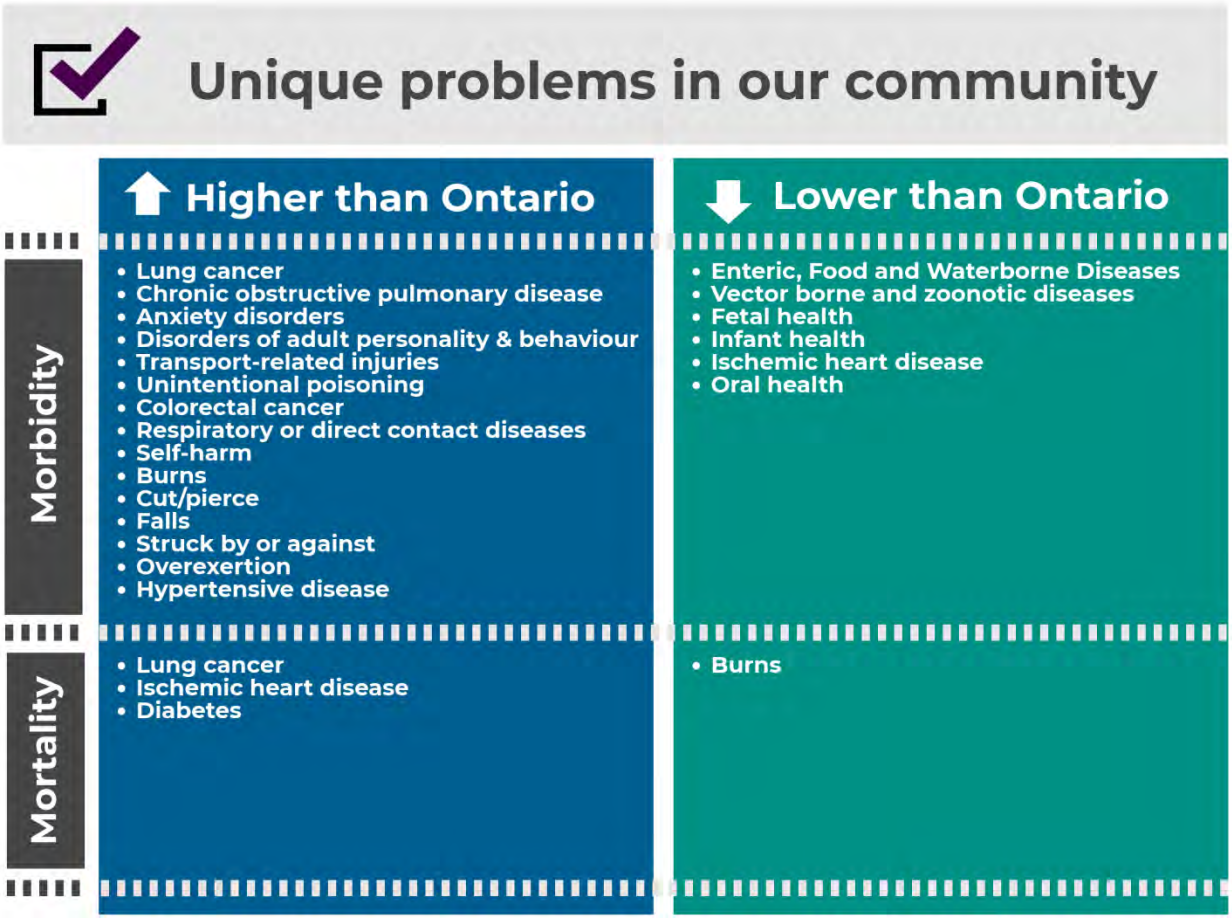
Table 5. Potential years of life lost (PYLL) for health outcomes, City of Hamilton (2012).

Health Outcome	PYLL Count	PYLL Rate (per 100,000)
Ischemic heart disease	2512	5.02
Infant health	1873	3.75
Lung cancer	1744	3.49
Self-harm	1512	3.02
Female breast cancer	740	2.96
Unintentional poisoning	1007	2.01
Diabetes	984	1.97
Fetal health	825	1.65
Colorectal cancer	686	1.37
Transport-related injuries	639	1.28
Cerebrovascular disease	564	1.13
Chronic obstructive pulmonary disease	492	0.98
Substance related disorders	346	0.69
Prostate cancer	136	0.54
Cervical cancer	128	0.51
Sexually transmitted & blood-borne infections	238	0.48
Assault	219	0.44
Malignant melanoma	151	0.30
Oral cancer	134	0.27
Hypertensive disease	115	0.23
Near-drowning/submersion	110	0.22
Falls	85	0.17
Kidney disease	55	0.11
Respiratory or direct contact diseases	51	0.10
Cut/pierce	43	0.09
Struck by or against	15	0.03
Asthma	8	0.02
Weather related events	4	0.01
Enteric, Food and Waterborne Diseases	0	0.00
Vector borne and zoonotic diseases	0	0.00
Oral health	0	0.00
Neurotrauma	0	0.00
Overexertion	0	0.00
Schizophrenia, delusional and non-organic psychotic disorders	0	0.00
Mood/affective disorders	0	0.00
Anxiety disorders	0	0.00
Selected disorders of adult personality and behaviour	0	0.00
Burns	0	0.00

Is the health outcome uniquely problematic in our community?

Understanding health outcomes that are uniquely problematic in our community can help determine the appropriateness of responding to those health outcomes. To determine which health outcomes are unique to our community, we can compare morbidity and mortality measures against another population that is a relevant comparator. In this assessment, Hamilton measures were compared to equivalent measures for the province of Ontario.

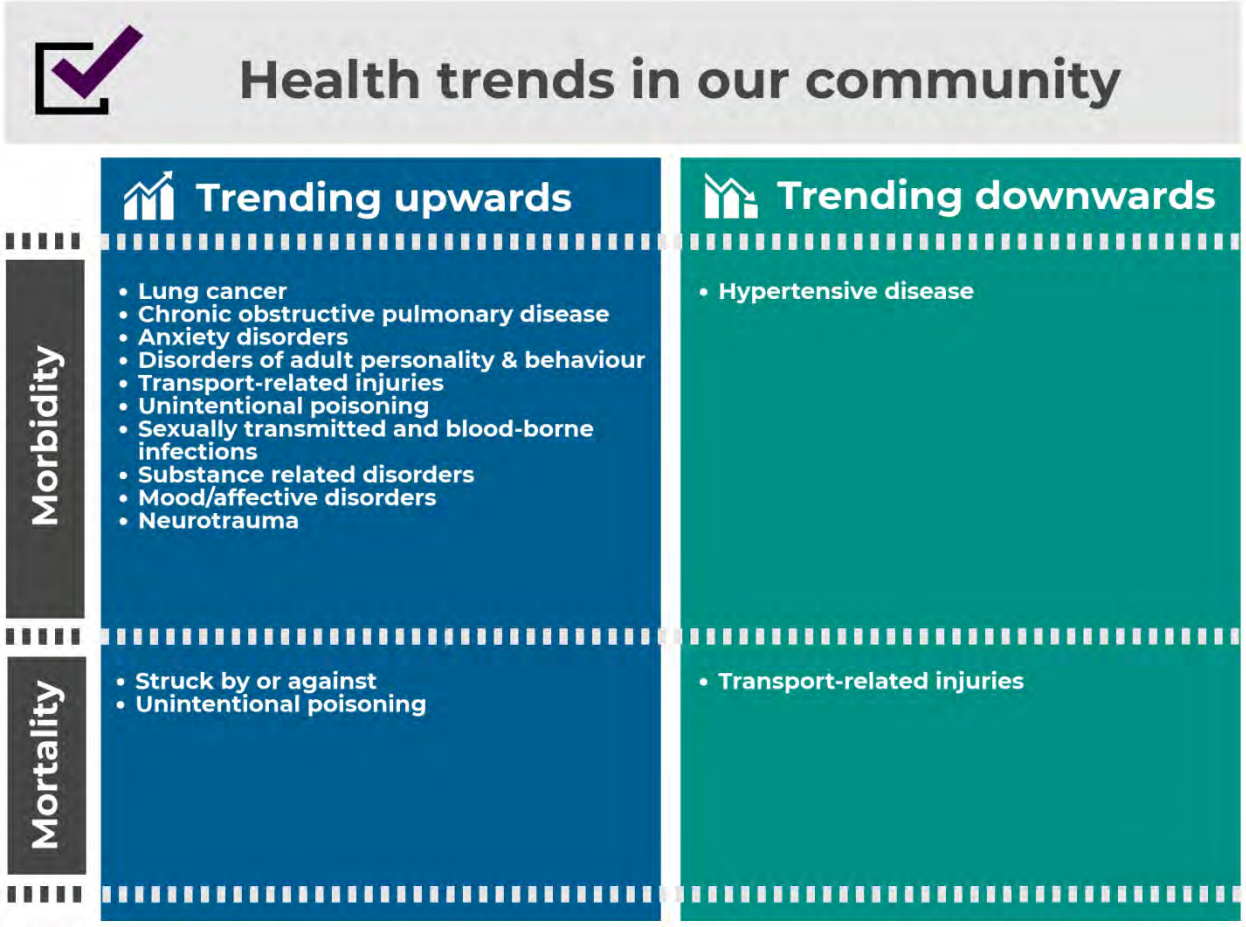
Hamilton had a number of morbidity and mortality measures that were significantly greater than the equivalent provincial measures. Most notably, both the incidence and mortality rates for lung cancer were significantly greater than the comparative provincial measures. There were several morbidity measures that were significantly lower in Hamilton, particularly for reportable infectious diseases, reproductive health, and ischemic heart disease. Mortalities due to burn injuries were also lower in Hamilton.



Is the health outcome getting worse in our community?

Being able to identify emerging trends in health data is part of the core objectives of public health epidemiology[3]. Assessment of trends and changes in health status is also a requirement of public health's mandate[1]. The identification of emerging trends in our community allows for a timely and effective public health response to the health needs of our population. In this assessment, trends in health outcomes were assessed for the most current 5 year period in Hamilton.

There were a number of morbidity and mortality measures that demonstrated an increasing (upwards) trend in Hamilton. The most notable trend was for unintentional poisonings which saw a significant increase in both morbidity and mortality rates over the past 5 years. The only significant decreasing (downwards) trends were for the hospitalization rate for hypertensive disease and transport-related mortality rate.



Overall Priority and Summary of Disease Burden

Health outcomes were scored using the previously described criteria (refer to **Table 1** in Methods section) and then prioritized according to total score. The overall scoring and prioritization of the health outcomes is summarized in **Table 6** at the end of this section.

The health outcomes ranking first overall were lung cancer, unintentional posisoning, and chronic obstructive pulmonary disease, which all had a tied score of 8 out of 11 points. In 2012, these top three health outcomes caused a total of 531 preventable deaths in Hamilton. Each of these health outcomes are described in more detail below.

Lung Cancer

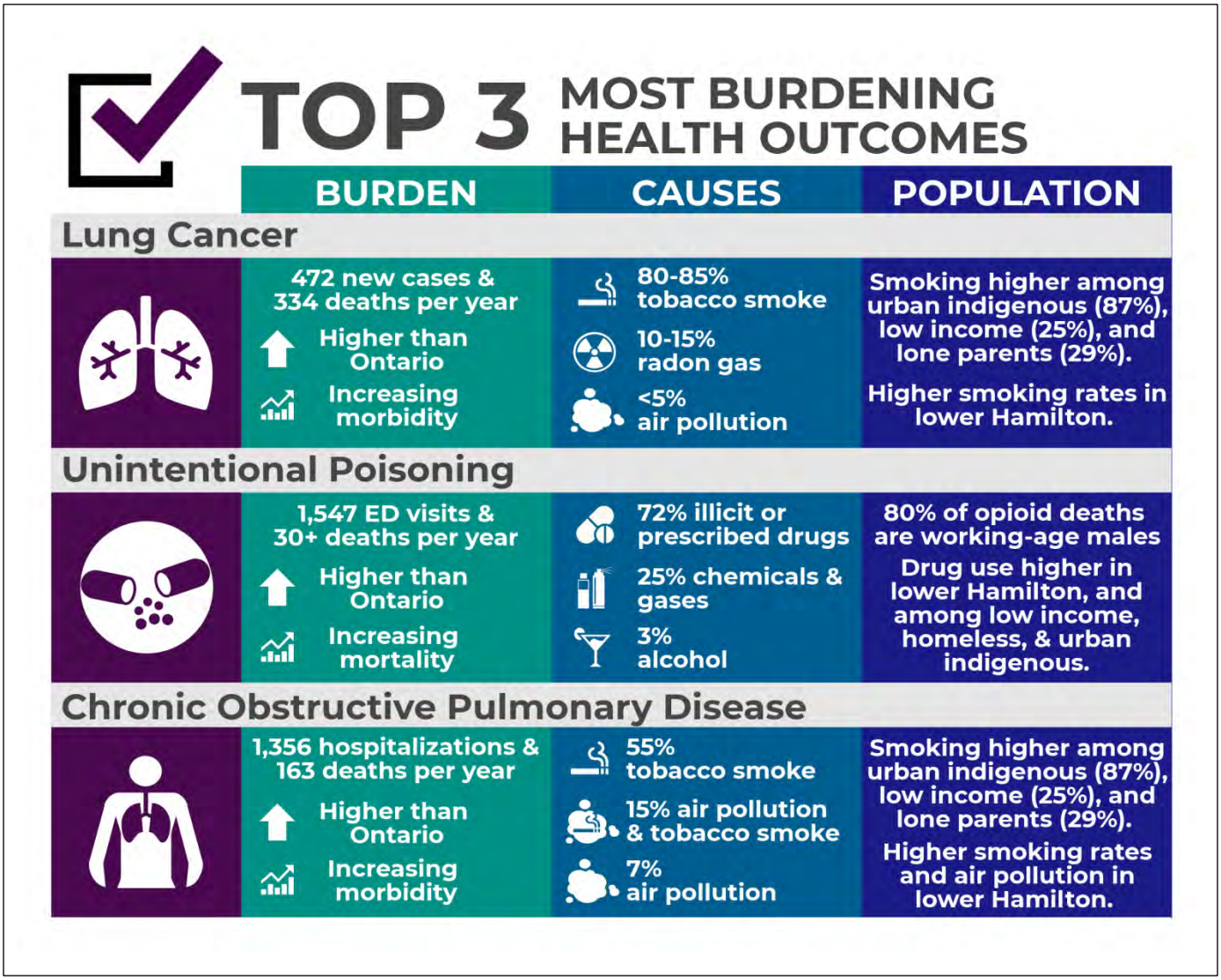
In 2012, there were 472 new cases and 334 deaths due to lung cancer in Hamilton. The local morbidity and mortality rates are significantly greater than Ontario, and morbidity rates are trending upwards in Hamilton. It is estimated that 80-85% of lung cancer cases are attributed to tobacco smoke[6,7], 10-15% are attributed to radon gas exposure[8], and less than 5% are attributed to outdoor air pollution[7]. Smoking is particularly higher among urban indigenous (87% report smoking)[9], low income (25% report smoking)[10], and lone parents (29%)[10] in Hamilton (follows statistically significant provincial trends). Residential radon gas is of greater concern to individuals dwelling in homes that have a basement, particularly if the basement has a living space and if a smoker resides within the dwelling[8]. Air pollution, although a minor contributor to lung cancer, is higher in specific areas of lower Hamilton and along major transportation corridors[11].

Unintentional Poisoning

Medical, recreational, or occupational exposure to substances can result in accidental poisoning of individuals. There were 1,547 ED visits (2017) and over 30 deaths (2012) caused by unintentional poisoning in Hamilton. Both morbidity and mortality measures are trending upwards, and Hamilton's morbidity for unintentional poisonings is significantly greater than Ontario. Over 70% of accidental poisonings are caused by an illicit or prescribed drug, while 25% are caused by exposure to a chemical or gas. Opioid-related poisonings are driving the increasing trend in Hamilton; 80% of opioid-related deaths were working-age males[12] and 19% of urban indigenous report recreational use of opioids in the past year[9]. ED visits for drug use and drug-related criminal activity were higher in lower Hamilton[13]. A survey of recent injection drug users found 20% were homeless, 71% earned less than $20,000 per year, and 25% were indigenous[13].

Chronic Obstructive Pulmonary Disease

In Hamilton, there were 1,356 hospitalizations (2017) and 163 deaths (2012) due to COPD. The local morbidity measure for COPD is greater than Ontario and it is increasing. It is estimated that 55% of COPD cases are attributed to smoking tobacco only, 15% are attributed to a combination of tobacco smoke and air pollution, and 7% are attributed to air pollution only[14]. Smoking is particularly higher among urban indigenous (87% report smoking)[9], low income (25% report smoking)[10], and lone parents (29%)[10] in Hamilton (follows statistically significant provincial trends). Males, middle-aged adults, and non-immigrants also had marginally higher rates of smoking[10]. Air pollution is higher in specific areas of lower Hamilton and along major transportation corridors[11]. In Hamilton, 2 in 3 long-term care homes and 1 in 3 elementary schools are located in a traffic-related air pollution zone[15].



The health outcome with the lowest score was vector-borne and zoonotic diseases (0 out of 11 points). Enteric, food- and water-borne diseases and weather-related health outcomes, and oral health were the next lowest ranked health outcomes (each scored 1 out of 11 points). These health outcomes ranked low for several reasons: outcomes are very uncommon, actual severity is low, trends are not increasing, and these are not unique local problems.

In addition, an alternate scenario was developed to test the inclusion of disability-adjusted life year estimates in the prioritization criteria. The description and results of this alternate prioritization scenario are reported in **Appendix C**.

Table 6. Overall scoring and prioritization of health outcomes in the City of Hamilton.

Rank	Health Outcome	Impact many people?	Is it severe?		Is it a unique local problem?		Is it getting worse?		Sum of Scores
		MORB	MORT	PYLL	MORB	MORT	MORB	MORT	
1	Lung cancer	✔✔	✔	✔✔	✔	✔	✔		8
	Unintentional poisoning	✔✔	✔	✔✔	✔		✔	✔	8
	Chronic obstructive pulmonary disease	✔✔	✔✔	✔✔	✔		✔		8
2	Self-harm	✔✔	✔✔	✔✔	✔				7
	Ischemic heart disease	✔✔✔	✔✔	✔✔	—	✔			7
	Diabetes	✔✔	✔✔	✔✔		✔			7
	Colorectal cancer	✔✔	✔✔	✔✔	✔				7
	Transport-related injuries	✔✔✔	✔	✔✔	✔		✔	—	7
	Falls	✔✔✔	✔✔	✔	✔				7
3	Sexually transmitted and blood-borne infections	✔✔✔	✔	✔			✔		6
	Cerebrovascular disease	✔✔	✔✔	✔✔					6

Rank	Health Outcome	Impact many people?	Is it severe?		Is it a unique local problem?		Is it getting worse?		Sum of Scores
		MORB	MORT	PYLL	MORB	MORT	MORB	MORT	
	Fetal health	✔✔✔	✔✔	✔✔	—				6
	Infant health	✔✔✔	✔✔	✔✔	—				6
	Struck by or against object	✔✔✔		✔	✔			✔	6
	Female breast cancer	✔✔	✔✔	✔✔					6
	Kidney disease	✔✔	✔✔	✔					5
	Assault	✔✔✔	✔	✔					5
4	Cut/pierce	✔✔✔		✔	✔				5
	Prostate cancer	✔✔	✔✔	✔					5
	Respiratory or direct contact diseases	✔✔	✔	✔	✔				5
	Neurotrauma	✔✔✔					✔		4
	Anxiety disorders	✔✔			✔		✔		4
5	Substance related disorders	✔	✔	✔			✔		4
	Overexertion	✔✔✔			✔				4
	Malignant melanoma	✔	✔	✔					3
	Cervical cancer	✔	✔	✔					3
6	Mood/affective disorders	✔✔					✔		3
	Oral cancer	✔	✔	✔					3
	Near-drowning or submersion	✔	✔	✔					3

Rank	Health Outcome	Impact many people?	Is it severe?		Is it a unique local problem?		Is it getting worse?		Sum of Scores
		MORB	MORT	PYLL	MORB	MORT	MORB	MORT	
	Selected disorders of adult personality and behaviour	✔			✔		✔		3
	Hypertensive disease	✔	✔	✔	✔		–		3
7	Asthma	✔	✔						2
	Burns	✔✔			✔	–			2
	Schizophrenia, delusional, non-organic psychotic disorders	✔✔							2
8	Oral health	✔✔			–				1
	Weather related events	✔							1
	Enteric, food and waterborne diseases	✔	✔		–				1
9	Vector borne and zoonotic diseases	✔			–				0

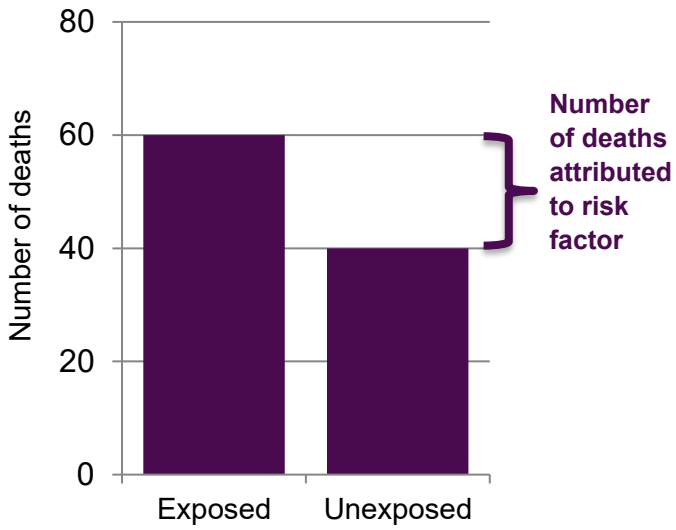
Notes:

- MORB – morbidity; MORT – mortality; PYLL – Potential Years of Life Lost.
- Under the prioritization scoring criteria, each checkmark (✔) represents +1 point and each minus sign (–) represents -1 point. Blank cells represent 0 points.

Drivers of Disease

In addition to prioritizing local health outcomes, it is also important to consider risk factors that drive illness and injury in our community. Risk factors are a characteristic, behaviour, or exposure that increases the probability of a health outcome. A single risk factor may increase the chance of several health outcomes (e.g., smoking increases the risk of lung cancer, COPD, heart disease).

The number of deaths attributed to each risk factor can be calculated using the population attributable fraction/ risk (PAR). Each health outcome has a unique PAR for each risk factor (e.g., 85% of lung cancer deaths are attributed to smoking tobacco). For this assessment, the total number of deaths attributed to each risk factor were calculated using Canadian PAR estimates from the Institute for Health Metrics and Evaluation. Gaps in PAR estimates were supplemented with data from the literature.



Mortalities resulting from the 38 health outcomes in this assessment were compared against 74 modifiable risk factors. Overall, the number of deaths attributed to the top 10 risk factor categories are reported in **Table 7** in ranked order for the population of Hamilton (2012). The largest fraction of preventable deaths in Hamilton were attributed to metabolic risk factors, which is a category that includes body-mass index, blood pressure, cholesterol, kidney function, plasma glucose, and bone density. Diet and tobacco were the next top risk factor categories linked to a large proportion of preventable deaths in Hamilton. Overall, 82% of preventable deaths in Hamilton were attributed to metabolic, dietary, and tobacco-related risk factors.

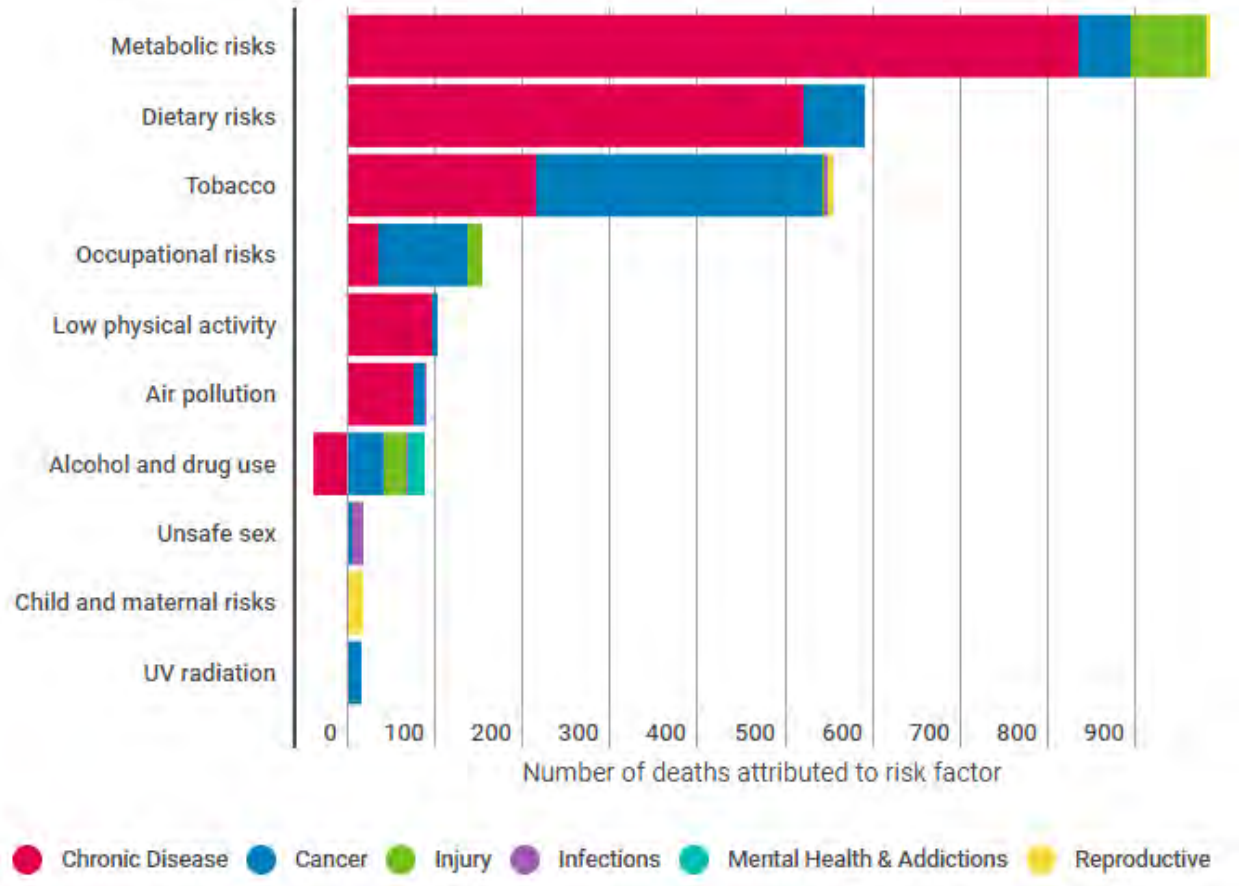
It is important to note that the duration between exposure and death varies considerably for each health outcome. For example, lung cancer may be attributed to smoking tobacco over the course of 20 to 50 years. Hence, some mortality data may be representative of risk factors that have occurred over a long period of time, particularly for chronic diseases. Lastly, disease is usually the result of a combination of risk factors and thus the same death may be attributed to more than one risk factor.

Table 7. Estimated deaths attributed to risk factors in Hamilton, 2012.

Rank	Risk factors	Deaths attributed to risk factor	Health outcomes linked to risk factor (estimated number of deaths)
1	**Metabolic risks** (e.g., body mass index, cholesterol, blood pressure)	984	Ischemic heart disease (490) Diabetes (144) Cerebrovascular disease (118)
2	**Dietary risks** (e.g., fruit and vegetable, sodium, processed food)	590	Ischemic heart disease (404) Cerebrovascular disease (57) Colorectal cancer (48)
3	**Tobacco** (e.g., active and passive cigarette smoke)	553	Lung cancer (285) COPD (131) Ischemic heart disease (58)
4	**Occupational risks** (e.g., carcinogens, injury)	155	Lung cancer (101) COPD (16) Ischemic heart disease (13)
5	**Low physical activity**	103	Ischemic heart disease (75) Cerebrovascular disease (17) Diabetes (4)
6	**Air pollution** (e.g., indoor and outdoor air quality)	90	Ischemic heart disease (45) COPD (21) Lung cancer (13)
7	**Alcohol and drug use**	52	Breast cancer (18) Self-harm (16) Colorectal cancer (16)
8	**Unsafe sex**	19	STBBIs (12) Cervical cancer (6)
9	**Child and maternal risks** (e.g., low birth weight)	19	Infant mortality (19)
10	**Ultraviolet radiation**	15	Malignant melanoma (15)

Data Source: Population attributable risk estimates were sourced from the Institute for Health Metrics and Evaluation's Global Burden of Disease Results Tool (Canada, 2016).

Figure 2. Estimated outcome-specific deaths attributed to risk factors in Hamilton, 2012.



Data Source: Population attributable risk estimates were sourced from the Institute for Health Metrics and Evaluation's Global Burden of Disease Results Tool (Canada, 2016).

Conclusion

This assessment was able to quantify and prioritize the burden of disease in the City of Hamilton for preventable health outcomes. It is expected that this assessment will inform broader priority setting that considers this population health assessment (local context) alongside other factors, including effectiveness of public health interventions, regulatory/ mandated priorities, community and political preferences, and available resources. Overall, the key findings from this assessment are stated below.

Injuries are among the most commonly occurring health outcomes in Hamilton and represent a large, but avoidable, burden on the healthcare system.

- 52,000 emergency department visits for injuries annually in Hamilton.

Chronic disease and cancer are among the most common causes of preventable deaths in Hamilton.

- 1,800 deaths from chronic disease and cancer could be avoided each year.

Lung cancer and COPD are among the top 3 most burdening health outcomes in Hamilton.

- Locally, lung cancer and COPD caused 498 preventable deaths in 2012; it is estimated that 416 of these deaths are attributed to tobacco smoke.

Medical, recreational, or occupational exposure to substances can result in unintentional poisoning; this is one of the top 3 most burdening health outcomes in Hamilton.

- Exposure to illicit or prescribed drugs is the most common cause of unintentional poisonings.
- The increasing trend in unintentional poisonings is being driven by opioids; Hamilton's opioid deaths have tripled from 26 in 2005 to 87 in 2017.

Metabolic, dietary, and tobacco-related risk factors are the major drivers of disease in Hamilton.

- 82% of preventable deaths were attributed to metabolic risks, diet, and tobacco in Hamilton (2012).

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Appendix A

Supplementary Table 1. Definitions and International Classification of Disease (ICD) codes for selected health outcomes.

Topic	Health Outcome	ICD-10-CA Codes	Definition
Cancer	Cervical cancer	C53	Malignant neoplasm of cervix uteri among females
	Colorectal cancer	C18-C20, C26.0	Malignant neoplasm of colon, rectosigmoid junction, rectum, and other
	Female breast cancer	C50 (female only)	Malignant neoplasm of breast among females
	Lung cancer	C34	Malignant neoplasm of bronchus and lung
	Malignant melanoma	C43	Malignant melanoma of skin
	Oral cancer	C00-C14	Malignant neoplasm of the oral cavity and pharynx
	Prostate cancer	C61	Malignant neoplasm of prostate among males
Chronic disease	Ischemic heart disease	I20-I25	Ischemic heart diseases
	Cerebrovascular disease	I60-I69	Cerebrovascular diseases
	Hypertensive disease	I10-I15	Hypertensive diseases
	Chronic obstructive pulmonary disease	J40-J44	Chronic obstructive pulmonary diseases including bronchitis, emphysema, and other (excludes asthma)
	Asthma	J45	Asthma
	Diabetes	E10-E14	Diabetes mellitus
	Kidney disease	N17-N19	Renal failure, including acute renal failure, chronic kidney disease, and unspecified
Infectious and Communicable diseases	Enteric, Food and Waterborne Diseases	A06, A05.1, A04.5, A00, A07.8, A09, A07.1, B15.0, B15.9, A32, T61, A01.4, A80, A02.0, A02.1, A02.2, A02.8, A02.9, A03, B75, A01.0, A04.3	Amebiasis, botulism, campylobacter enteritis, cholera, cryptosporidiosis, cyclosporiasis, food poisoning, giardiasis, hepatitis A, listeriosis, paralytic shellfish poisoning, paratyphoid fever, acute poliomyelitis, salmonellosis, shigellosis, trichinosis, typhoid fever, verotoxin-producing E. coli, yersiniosis

Topic	Health Outcome	ICD-10-CA Codes	Definition
	Respiratory or direct contact diseases	A22, A23, A36, G04.9, A40.0, A49.1, B95.0, G00.2, P36.0, A41.3, A49.2, B96.3, G00.0, J05.1, J14, P23.6, B33.4, A92.4, A96.2, A98.0, A98.4, A98.3, A99, J10, A96.2, A48.1, A48.2, A30, B05, A39, B26, A54.3, A37, A70, B06, U04, B03, A40.3, B95.3, G00.1, J13, M00.1, A15-A19	Anthrax, Brucellosis, Diphtheria, Encephalitis/Meningitis, Group A Streptococcal Disease, Invasive, Group B Streptococcal Disease, Neonatal, Haemophilus Influenzae B, Invasive, Hantavirus Pulmonary Syndrome, Hemorrhagic Fevers, Influenza, Lassa Fever, Legionellosis, Leprosy, Measles, Meningococcal Disease, Invasive, Mumps, Ophthalmia Neonatorum, Pertussis (Whooping Cough), Psittacosis/Ornithosis, Rubella, Severe Acute Respiratory Syndrome (SARS), Smallpox, Streptococcus Pneumoniae, Invasive, Tuberculosis (Active)
	Sexually transmitted and blood-borne infections	A57, A56, A54, B16, B18.2, B24, A51.2, A51.4, A51.5, A52.8, A52.3, A50.2	Chancroid, Chlamydial Infections, Gonorrhea, Hepatitis B, Hepatitis C, HIV, Syphilis
	Vector borne and zoonotic diseases	A69.2, B54, A20, A78, A82, A21, A923, A95	Lyme Disease, Malaria, Plague, Q Fever, Rabies (Human), Tularemia, West Nile Virus Illness, Yellow Fever
Dental	Oral health	K01.1, K02, K04.4, K04.5-K04.7, K05.0-K05.2, K07.6, K08.8, K11.9, K12.2	Oral health conditions including dental caries and abscesses
Environmental health	Weather related events (including heat, cold, other)	X30-X39	Exposure to sunlight, natural heat, natural cold, victim of cataclysmic storm, flood, lightning, avalanche, landslide, and other earth movements, and other/unspecified forces of nature
Injury (intentional)	Assault	X85-Y09, Y87.1	Injuries inflicted by another person with intent to injure or kill (includes all means of assault)
	Self-harm	X60-X84, Y87.1	Purposely self-inflicted poisoning or injury (attempted or completed suicide)
Injury (unintentional)	Burns	X00-X19	Injuries resulting from exposure to smoke, fire, and flames caused unintentionally
	Cut/pierce	W25-W29, W45, W46	Injuries resulting from cuting or piercing by sharp object or other foregin body penetrating the skin
	Falls	W00-W19	Injuries resulting from falling
	Near-drowning or submersion	W65-W74,V90, V92	Injuries resulting from drowning or submersion (includes bathtubs and pools, natural water, and water transport accidents)

Topic	Health Outcome	ICD-10-CA Codes	Definition
	Neurotrauma	F072, S020-S023, S027-S029, S06, S071, T902, T905, S140, S141, S240, S241, S340, S341, S343, T060, T061	Injuries resulting from neurotrauma including concussions, brain injury, and skull or facial fractures
	Struck by or against	W20-W22, W50-W52	Injuries resulting from unintentional exposure to an inanimate or animate mechanical force
	Transport-related injuries	V01-V89	Injuries resulting from traffic and off-road motor vehicle collisions.
	Unintentional poisoning	X40-X49	Injuries resulting from accidental poisoning by and exposure to substances (include prescription and illicit drugs, alcohol, gases and vapours, and other noxious substances)
	Overexertion	X50	Injuries resulting from overexertion
Mental health	Substance related disorders	F10 to F19, F55	Mental and behavioural disorders due to psychoactive substance use including acute intoxication, harmful use, dependence, withdrawal, delirium, psychotic disorder, amnesia, and other
	Schizophrenia, delusional and non-organic psychotic disorders	F20 (excluding F20.4), F22, F23, F24, F25, F28, F29, F53.1	Schizophrenia, delusional and non-organic psychotic disorders
	Mood/affective disorders	F30, F31, F32, F33, F34, F38, F39, F53.0	Mood and affective disorders, including bipolar, manic or depressive episode, and other mood disorders
	Anxiety disorders	F40, F41, F42, F43, F48.8, F48.9, F93.8	Anxiety disorders, including phobic anxiety disorder, obsessive compulsive disorder, severe stress and adjustment disorders, and other disorders
	Selected disorders of adult personality and behaviour	F60, F61, F62, F68, F69, F21	Selected disorders of adult personality and behaviour
Reproductive	Fetal health	All	Any health outcome experienced by fetus prior to the complete expulsion or extraction from its mother
	Infant health	All	Any health outcome experienced by a live born infant before the 365th day of life.

Appendix B

PHO Infectious Disease Query

Infectious Disease Query is a dynamic data exploration tool that allows users to drill down and explore data. Content focuses on aggregated reportable infectious disease data extracted from the integrated Public Health Information System (iPHIS). Access to Query is limited to authorized public health professionals. iPHIS is a dynamic disease reporting system which allows ongoing updates to data previously entered. As a result, data extracted from iPHIS represent a snap shot at the time of extraction and may differ from previous or subsequent reports. The data only represent cases reported to public health and recorded in iPHIS. As a result, all counts will be subject to varying degrees of underreporting due to a variety of factors, such as disease awareness and medical care seeking behaviours which may depend on severity of illness, clinical practice, changes in laboratory testing, and reporting behaviours. Only provincial case classifications, as listed in the Ontario Ministry of Health and Long-Term Care (MOHLTC) surveillance case definitions are included in the report counts. Cases are excluded if they do not meet the provincial case classifications in place at the time that the case was reported. Query is intended to be a data exploration tool. Public Health Ontario cannot guarantee or warrant the accuracy or timeliness of the information generated by this tool. Public health units are responsible for ensuring that cases reported to the province meet the relevant case definition.

BORN BIS

The Better Outcomes Registry and Network (BORN) Ontario: The Better Outcomes Registry and Network (BORN) Ontario is a maternal-newborn registry by web-based data entry (BORN Information System – BIS). The BORN Information System (BIS) enables the collection of, and access to, data on every birth and young child in Ontario. Sourced from hospitals, labs, midwifery practice groups and clinical programs, the data are collected through a variety of mechanisms including HL7, batch upload, and manual entry. Hospital sites either manually enter data directly into the BIS or upload data from their own databases. Record level information is captured for both the maternal and infant variables. BORN is comprised of Niday Perinatal Database, Fetal Alert Network, Multiple Marker Screening Program, Ontario Midwifery Program and Newborn Screening Ontario databases. Note: BORN PHU data are reported using submitted records from the BIS, which may or may not be acknowledged by the submitting hospital. This may lead to potential fluctuations in recent data as hospital sites submit additional records or update existing records prior to the close of each fiscal year. Data presented here represents information extracted via the BORN BIS Public Health Standard Reports using birth location Public Health Unit or comparator province.

CCO SEERStat

Ontario Cancer Registry (OCR): The OCR, housed at Cancer Care Ontario (CCO), is a computerized databased of information on all Ontario residents who have been newly diagnosed with cancer ("incidence") or who have died of cancer ("mortality"). All new cases of cancer are registered, except non-melanoma skin cancer. The OCR is compiled by linking administrative data, clinical and demographic data from four major sources: 1) hospital discharge and same day surgeries from the Canadian Institute for Health Information (CIHI), 2) death certificates from the Registrar General, 3) pathology reports from laboratories, and 4) treatment records from the regional cancer centres and Princess Margaret Hospital. Cancer diagnoses are classified according to the International Classification of Disease for Oncology, 3rd edition (ICDO-3). Registry data is distributed using the SEERStat software program.

NACRS Emergency Department Visits

Ambulatory care visits are a source of morbidity information available through IntelliHealth originally from the National Ambulatory Care Reporting System (NACRS), Canadian Institute for Health Information (CIHI). NACRS contains data for all hospital-based and community-based ambulatory care: Day surgery, Outpatient and community-based clinics, and Emergency departments. Client visit data is collected at time of service in participating facilities. CIHI receives data directly from participating facilities or from regional health authorities or ministries of health. Data collection methods may vary by facility. Data presented here only represent unplanned emergency visits available via the IntelliHealth IBM Cognos environment. Geography was determined using Public Health Unit or patient province as designated in the Cognos SAS environment.

DAD Hospitalization

Inpatient discharges are a source of morbidity information available through IntelliHealth originally from the Discharge Abstract Database (DAD), Canadian Institute for Health Information (CIHI). The DAD captures administrative, clinical and demographic information on hospital discharges (including deaths, sign-outs and transfers). Data is received directly from acute care facilities or from their respective health/regional authority or ministry/department of health. Facilities in all provinces and territories except Quebec are required to report. Data presented here only represent inpatient discharges from acute care facilities available via the IntelliHealth IBM Cognos environment. Geography was determined using Public Health Unit or patient province as designated in the Cognos SAS environment.

OMHRS Assessment, Treatment, Diagnosis

The "IP Adult MH Assessment, Treatment, Diagnosis" describes information on assessments, treatments & diagnoses for patients admitted to an ADULT psychiatric (MH) bed in a mental health unit - can be multiple (or no) records per admit, it includes children if treatment recommended in adult beds. The information contained in the Inpatient Mental Health tables was obtained from the Ontario Mental Health Reporting System (OMHRS). Since OMHRS is "admission based", open or non-discharged cases that are still being treated at the time of reporting are part of the data. The same patient can be re-admitted for a different disorder or the same disorder and be counted twice under # of admits. During their stay, patients are assessed at prescribed intervals, with the possibility of each assessment yielding a different result. Since adult designated mental health bed is not restricted on the age of the patient but rather on the type of bed, there will be cases where children and adolescents mental health treatment is being captured in the Adult Mental Health Tables (~2% of cases are under the age of 18). Geographic information is based on patient's place of residence. Designated inpatient mental health beds in Ontario include general hospitals with designated adult mental health beds, specialty psychiatric hospitals (e.g., CAMH), and provincial psychiatric hospitals.

Psychiatric Diagnoses are categorized by the Diagnostic and Statistical Manual of Mental Disorders, 4th. Edition (DSM-IV), the manual is published by the American Psychiatric Association and covers all mental health disorders. Up to 3 provisional diagnoses according to broad DSM-IV diagnostic categories can be provided at each assessment. The information is obtained from either the patient's psychiatrist or attending physician. DSM-IV Primary Dx Category is used to filter diagnosed mental disorder by admission counts. In 2016, psychiatric diagnoses coding converted to version DSM-V. To maintain the integrity of the comparison over time, analysis excluded data from 2016.

Vital Stats Deaths

Vital statistics are a source of mortality information available through IntelliHealth originally from the Office of the Registrar General (ORG), ServiceOntario. ORG obtains information about mortality from death certificates which are completed by physicians. All deaths within Ontario are registered in the office of the division registrar within which the death occurs. The ORG provides death registration data to Statistics Canada for national reporting. With the ORG's approval, Statistics Canada provides the Ministry of Health and Long Term Care with an edited and standardized dataset for deaths that occurred in Ontario, which is uploaded to IntelliHealth. Data presented here only represent deaths available via the IntelliHealth IBM Cognos environment. Geography was determined using Public Health Unit or patient province as designated in the Cognos SAS environment.

Appendix C

Disability-adjusted life years (DALYs) measure the total disability burden of disease in populations by accounting for quality of life and early death. DALYs are calculated using years of life lost (YLL) and years lost due to disability (YLD):

$$DALY = YLL + YLD$$

YLL values are available for the population of Hamilton, but exact YLD values are not available at the local level due to the lack of accurate incidence data for many health outcomes (as previously described in the limitations section of this assessment's methodology). Nevertheless, YLD values were estimated based on national rates calculated by the Institute for Health Metrics and Evaluation[16]. The extrapolation of national estimate to local context is a limitation of this analysis. The estimated DALYs for health outcomes in Hamilton are reported in **Supplementary Table 2**.

Given the current limitations associated with determining local DALYs, these values were not included within the primary criteria for prioritization of health outcomes in Hamilton. However, an alternate scenario was developed to test the inclusion of DALYs within the prioritization criteria. In the alternate scenario, DALYs replaced PYLL under the second criteria in the prioritization tool (the scores and weighting did not change). The alternate prioritization of health outcomes was determined with the inclusion of DALYs (in lieu of PYLL) and the results are summarized in **Supplementary Table 3**.

There were minor changes in ranking in the alternate scenario based on DALYs. There was some movement between the first, second, and third rankings, but all health outcomes within the top three rankings were consistent between scenarios with the exception of fetal health (dropped to fifth ranking) and anxiety disorders (elevated to third ranking). In the alternative scenario lung cancer was still ranked first alongside fall injuries which were elevated from second place. COPD and unintentional poisonings dropped down to second place in the alternate scenario, but diabetes and ischemic heart disease maintained their second place ranking in the alternate scenario.

Even though there are limitations associated with local estimates of disability, it is still important for decision makers to consider the potential impact of including these measures in the prioritization criteria. However, inclusion of approximated local DALYs within the prioritization criteria resulted in a minor change in the ranking of health outcomes for Hamilton.

Supplementary Table 2. Disability-adjusted life years (DALY) for Hamilton, 2012.

Health Outcome	YLL	YLD	DALY
Overexertion	0	8391	8391
Diabetes	984	2428	3412
Mood/affective disorders	0	3099	3099
Substance related disorders	346	2726	3072
Ischemic heart disease	2512	511	3023
Anxiety disorders	0	2569	2569
Infant health	1873	601	2474
Falls	85	2016	2101
Oral health	0	1901	1901
Lung cancer	1744	80	1824
Cerebrovascular disease	563.8	1240	1804
Transport-related injuries	639	1051	1690
Self-harm	1512	99	1611
Asthma	8	1493	1501
Fetal health	825	423	1248
Schizophrenia, delusional, non-organic psychotic	0	1117	1117
Unintentional poisoning	1007	41	1048
Chronic obstructive pulmonary disease	492	522	1014
Selected disorders of adult personality & behaviour	0	921	921
Female breast cancer	740	150	890
Colorectal cancer	686	112	798
Cut/pierce	43	636	679
Struck by or against	15	636	651
Kidney disease	55	593	648
Neurotrauma	0	599	599
Assault	219	251	470
Sexually transmitted and blood-borne infections	238	61	299
Prostate cancer	136	124	260
Burns	0	249	249
Malignant melanoma	151	29	180
Hypertensive disease	115	56	171
Oral cancer	134	11	145
Cervical cancer	128	10	138
Near-drowning/submersion	110	16	126
Respiratory or direct contact diseases	51	22	73
Weather related events (including heat, cold, other)	4	64	68
Enteric, Food and Waterborne Diseases	0	0	0
Vector borne and zoonotic diseases	0	0	0

Supplementary Table 3. Alternate prioritization scenario of health outcomes in Hamilton based on disability-adjusted life year (DALY) estimates.

Rank	Health Outcome	Impact many people?	Is it severe?		Is it a unique local problem?		Is it getting worse?		Sum of Scores
		MORB	MORT	DALY	MORB	MORT	MORB	MORT	
1	Lung cancer	✔✔	✔	✔✔	✔	✔	✔		8
	Falls	✔✔✔	✔✔	✔✔	✔				8
2	Unintentional poisoning	✔✔	✔	✔	✔		✔	✔	7
	Chronic obstructive pulmonary disease	✔✔	✔✔	✔	✔		✔		7
	Ischemic heart disease	✔✔✔	✔✔	✔✔	—	✔			7
	Diabetes	✔✔	✔✔	✔✔		✔			7
3	Colorectal cancer	✔✔	✔✔	✔	✔				6
	Transport-related injuries	✔✔✔	✔	✔	✔		✔	—	6
	Self-harm	✔✔	✔✔	✔	✔				6
	Sexually transmitted and blood-borne infections	✔✔✔	✔	✔			✔		6
	Cerebrovascular disease	✔✔	✔✔	✔✔					6
	Infant health	✔✔✔	✔✔	✔✔	—				6
	Struck by or against object	✔✔✔		✔	✔			✔	6
	Overexertion	✔✔✔		✔✔	✔				6
	Anxiety disorders	✔✔		✔✔	✔		✔		6
4	Substance related disorders	✔	✔	✔✔			✔		5
	Fetal health	✔✔✔	✔✔	✔	—				5

Rank	Health Outcome	Impact many people?	Is it severe?		Is it a unique local problem?		Is it getting worse?		Sum of Scores
		MORB	MORT	DALY	MORB	MORT	MORB	MORT	
	Mood/affective disorders	✔✔		✔✔			✔		5
	Neurotrauma	✔✔✔		✔			✔		5
	Female breast cancer	✔✔	✔✔	✔					5
	Kidney disease	✔✔	✔✔	✔					5
	Assault	✔✔✔	✔	✔					5
	Cut/pierce	✔✔✔		✔	✔				5
5	Prostate cancer	✔✔	✔✔						4
	Respiratory or direct contact diseases	✔✔	✔		✔				4
	Selected disorders of adult personality and behaviour	✔		✔	✔		✔		4
6	Asthma	✔	✔	✔					3
	Schizophrenia, delusional, non-organic psychotic disorders	✔✔		✔					3
	Oral health	✔✔		✔✔	—				3
7	Malignant melanoma	✔	✔						2
	Cervical cancer	✔	✔						2
	Hypertensive disease	✔	✔		✔		—		2
	Oral cancer	✔	✔						2
	Near-drowning or submersion	✔	✔						2

Rank	Health Outcome	Impact many people?	Is it severe?		Is it a unique local problem?		Is it getting worse?		Sum of Scores
		MORB	MORT	DALY	MORB	MORT	MORB	MORT	
	Burns	✔✔			✔	–			2
8	Weather related events	✔							1
	Enteric, food and waterborne diseases	✔	✔		–				1
9	Vector borne and zoonotic diseases	✔			–				0

Notes:

- MORB – morbidity; MORT – mortality; DALY – disability-adjusted life years
- Under the prioritization scoring criteria, each checkmark (✔) represents +1 point and each minus sign (–) represents -1 point. Blank cells represent 0 points.

Health Check