Health Impacts of Cold Weather

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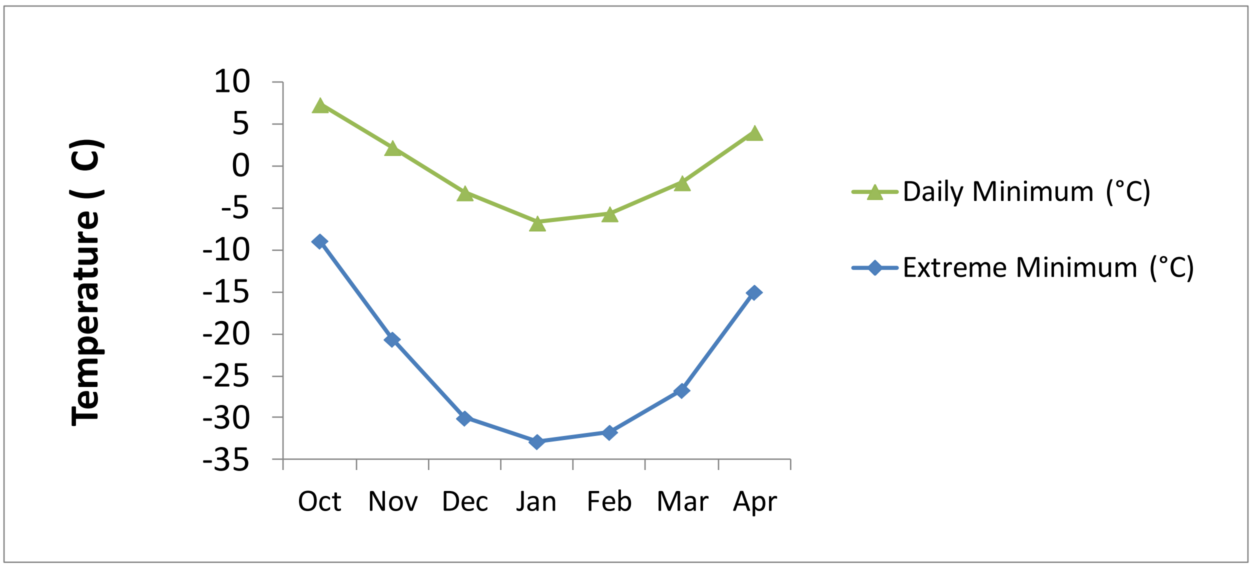
Introduction

Cold weather is associated with a range of health impacts. While the most immediate impacts are cold-related injuries such as frostbite and hypothermia, cold weather conditions also increase the risk of mortality and hospitalization from cardiovascular and respiratory health conditions. Preventing these health impacts in Toronto's population requires understanding the different types of cold-related health risks and vulnerable populations.

Cold Weather

Toronto residents may expect to experience cold and snowy weather conditions over the course of each winter. Extreme cold weather can be thought of as outdoor temperatures that are unusually low. Figure 1 shows that on average, temperatures between December and March are between -5 °C and -10 °C in Toronto. However, between 1981-2010, there were an average of 22 days each year with temperatures below -10 °C in Toronto. The coldest days were much colder, with temperatures sometimes dipping to -35 °C and below.

Figure 1: Average Daily Minimum and Extreme Minimum monthly temperatures in Toronto 1981-2010



Data Source: Environment Canada
Prepared by Toronto Public Health

Temperature is not the only factor that influences how people experience feelings of cold. Windy and wet conditions can make it feel colder than it actually is. To account for the effect of wind, Environment Canada uses a wind chill index to describe what the temperature feels like on exposed skin. Figure 2 illustrates that a given temperature is likely to feel colder as the wind speed increases. People who get wet may also feel colder than temperature conditions would suggest. As moisture evaporates from a person's skin or clothing, the individual also loses body heat. However, the level of humidity in the air does not affect the sensation of cold (Osczevski and Bluestein, 2002).

Figure 2: Wind Chill Chart (Environment Canada, 2014)

How to estimate wind chill values

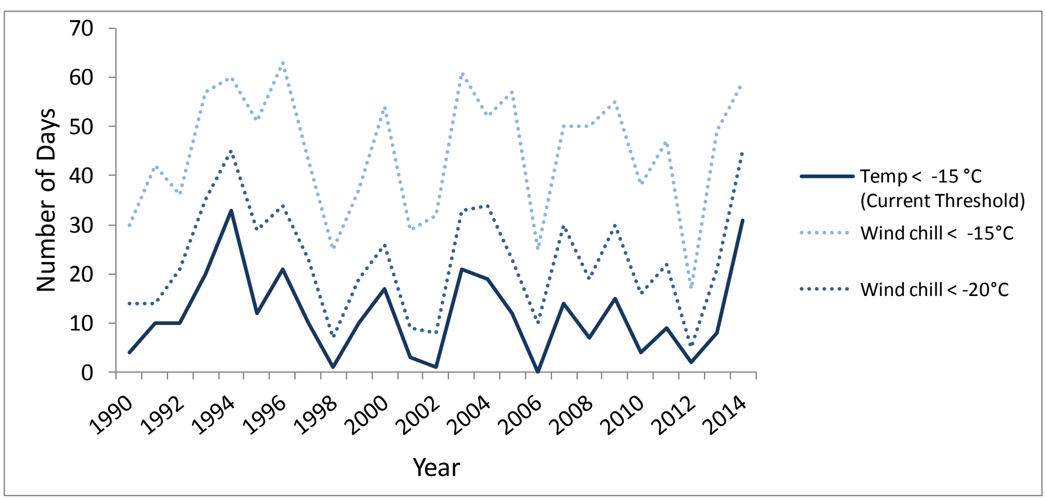
1. Estimate the wind speed outside by observing the movement of trees and flags, using the guide provided in the table below.
2. Once you have estimated the wind speed and you know the temperature outside, you can estimate the wind chill by referring to the numerical chart below.

Estimating Wind Chill

Wind Speed (km/h)	What to Look for When Estimating Wind Speed	Temperature (°C)									
		0	-5	-10	-15	-20	-25	-30	-35	-40	-45
10	Wind felt on face; wind vane begins to move.	-3	-9	-15	-21	-27	-33	-39	-45	-51	-57
20	Small flags extended.	-5	-12	-18	-24	-30	-37	-43	-49	-56	-62
30	Wind raises loose paper, large flags flap and small tree branches move.	-6	-13	-20	-26	-33	-39	-45	-52	-59	-65
40	Small trees begin to sway and large flags extend and flap strongly.	-7	-14	-21	-27	-34	-41	-48	-54	-61	-68
50	Large branches of trees move, telephone wires whistle and it is hard to use an umbrella	-8	-15	-22	-29	-35	-42	-49	-56	-63	-69
60	Trees bend and walking against the wind is hard.	-9	-16	-23	-30	-36	-43	-50	-57	-64	-71

Figure 3 shows the number of days with temperatures reaching -15 °C or below in Toronto between 1990-2014. The figure also shows the number of days with wind chill reaching -15 °C or below or -20 °C and below. The data shown in the figure reflects the large fluctuations that occur in the number of cold days in Toronto from year to year. The figure also confirms that 2014 was an especially cold winter compared with many other winters in the past 25 years.

Figure 3: Number of Days in Toronto with minimum temperatures below -15 °C and wind chill values below -15 °C and -20 °C between 1990-2014



Data Source: Environment Canada
Prepared by Toronto Public Health

Health Impacts of Cold Weather

The health impacts of cold weather include cold weather injuries and impacts on mortality and other chronic health conditions.

Cold Weather Injuries

Cold injuries can be classified as hypothermia, freezing injuries, and non-freezing injuries. Effects are relatively immediate for most cold weather injuries.

Hypothermia occurs when the body's core temperature drops below 37 °C. A body temperature that is too low affects the brain, making the victim unable to think clearly or move well. This makes hypothermia particularly dangerous because a person may not know it is happening and will not be able to do anything about it. Hypothermia is characterized by shivering, confusion and loss of muscular control (e.g., difficulty walking), and can progress to a life-threatening condition where shivering stops or the person loses consciousness. Cardiac arrest may occur.

Freezing injuries include frostnip and frostbite and occur when body tissues freeze. Frostnip is the milder of the two and involves freezing of the skin only. Frostbite is more severe and occurs when both the skin and the underlying tissue such as fat, muscle, and bone are frozen. In cold weather blood vessels near the skin's surface constrict in order to protect the body's core temperature. With long periods of exposure to cold, this can lead to reduced blood flow to extremities such as hands, feet, nose, and ears. These areas are then most likely to be affected by frostnip or frostbite. While frostnip is typically only associated with discomfort, untreated severe frostbite can lead to permanent nerve damage, blisters, and even to infection and loss of limbs.

Trenchfoot is an example of a non-freezing cold injury. Trenchfoot is often described as a "wet cold disease" and results from prolonged exposure in a damp or wet environment from above the freezing point to about 10 °C. Injury occurs because wet feet lose heat 25-times faster than dry feet. To prevent heat loss, the body constricts blood vessels to shut down circulation in the feet. Skin tissue begins to die because of lack of oxygen and nutrients and due to the buildup of toxic products. Symptoms of trench foot include reddening of the skin, numbness, leg cramps, swelling, tingling pain, blisters or ulcers, bleeding under the skin, and even gangrene.

In addition, windburn may occur when cold wind removes a top layer of oil from the skin, leading to dryness, itchiness, soreness, and redness.

Vulnerability to Cold Weather Injuries

A group that is especially at risk from acute cold-related injuries is people experiencing homelessness. In the United States, about 700 people experiencing or at risk of homelessness die from hypothermia annually (National Coalition for the Homeless, 2010). Surveillance in New York City found that hypothermia is a key risk for the unsheltered homeless population (Gambatese et al, 2013), and a review of hospital admissions for hypothermia in Paris found that 62% of people admitted were homeless (Rouquette et al 2011). Recent research conducted in Montreal and British Columbia also suggests that homelessness is an important factor in cold-related injury and death (Koutsavlis, 2003; Stares, 2014). These recent findings support an earlier review of homelessness and health in Canada which concluded that in cold weather, the risk of frostbite and hypothermia is substantial, and deaths due to freezing are not uncommon (Hwang, 2001).

Figure 4 shows the number of deaths in Canada attributable to exposure to excessive cold between 2007-2011. The figure shows that most deaths occur among those aged 44 to 65 years. On average, the number of deaths attributable to cold between 2007-2011 was 94 per year, with about 69% being males. These statistics do not include situations where cold was a factor that precipitated death from another cause (such as heart attack). These patterns suggest that hypothermia deaths in Canada are dominated by deaths in homeless populations. In Toronto, two-thirds of the homeless population is male, and the average age of homeless people is 42 (City of Toronto, 2013).

Figure 4: Number of deaths in Canada resulting from exposure to excessive cold (2007-2011)

Data Source: Statistics Canada
Prepared by Toronto Public Health

People experiencing homelessness are at greater risk of cold injuries because they are more likely to spend long periods of time outside, and so their exposure to cold is greater and longer than for most people. As well, many of the chronic problems faced by homeless people, including inadequate clothing, malnutrition, and underlying infection, increase the risk of developing and dying from hypothermia (O'Connell et al, 2004).

A number of studies additionally identify factors such as alcohol use, psychiatric disorders, and use of certain medications as risk factors for hypothermia. These are issues that are common among those experiencing homelessness, meaning that there can often be multiple overlapping risk factors that may contribute to an outcome of death due to hypothermia. For example, a Swedish study found that for people admitted to hospital with hypothermia, associated co-factors and co-morbidities included ethanol consumption, dementia, and psychiatric diagnosis

(Brändström, 2014). In New York City, risk factors for hypothermia deaths included alcohol dependence, a history of heart disease, a previous cold-weather injury, or age 45 years or older (Gambatese et al, 2013). In Montreal, male gender, alcohol intoxication, psychiatric illness, older age, and homelessness were suggestive of important risk factors in cold injury (Koutsavlis, 2003).

Deaths represent the most severe, and likely least common type of cold-related injury. Numbers of cold-related deaths represent the 'tip of the iceberg', with many more people expected to suffer non-fatal cold injuries. Some severe non-fatal impacts of cold exposure that have been described in people experiencing homelessness include amputation of affected areas or extended hospitalizations (O'Connell et al, 2004). Known risk factors for frostbite are similar to those for hypothermia. These include low temperature, wind, wetness, individual behaviour, existing co-morbidities including chronic conditions such as the presence of cardiovascular illness, diabetes and depression (Ikäheimo and Hassi, 2011).

Other groups that are vulnerable to cold injury include children, the elderly and those with circulation problems. However, homelessness may not always be the primary risk factor for these groups. For example, older adults who were hospitalized for hypothermia were more likely to be located indoors (e.g., in residential facilities or at home) than outdoors while becoming hypothermic (Hajat, 2007; Phu Pin, 2011; Chau, 2012). Risks for patients who had become hypothermic indoors included sepsis, psychiatric disorders, and living alone (Noe et al 2012).

Research conducted in the British Isles indicates that access to resources including financial is a factor in hypothermia deaths among the elderly. An Irish study found that material deprivation was a significant predictor of hypothermia-related mortality among elderly patients admitted to hospital (Romero-Ortuno, 2013). In elderly patients admitted to hospital in Scotland, the incidence of hypothermia was higher in non-ambulant patients and those with co-morbidity; the majority of patients lived in relatively deprived areas by a postcode derived deprivation index (Pedley at al 2002). In an English study, the impact of deprivation was only present in rural areas (Hajat, 2007). Reasons why vulnerable adults may have difficulty keeping warm included cost of fuel for heating, limited knowledge and awareness about the potential impacts of cold exposure, and difficulties associated with technology (Tod, 2012).

It is difficult to know how well these findings apply to Toronto. Research suggests that there is less cold-related mortality among the elderly in countries that usually experience cold winters, because there is more likely to be protections in place (Keatinge 2000). The UK has a much more temperate climate than Toronto, and their levels of cold-related mortality are elevated compared to more traditionally "northern" countries. A 2003 World Health Organization report additionally notes the ongoing debates in the UK about the role of poor housing, fuel poverty, and other socioeconomic issues affecting the elderly (Hales, 2003). Since then, the U.K developed and implemented a cold weather plan that begins to tackle some of these issues.

A full understanding of vulnerability to cold injuries may require further research into the impacts of socioeconomic or minority status. For example, research from the U.S. identified minorities such as Black and Native American as having significantly higher risk of hypothermia-related inpatient and outpatient visits (Noe et al 2012).

Thresholds for Effect

Environment Canada reports that the risk of hypothermia is present at a wind chill of -10 ºC and below for people who are outside for long periods of time without adequate protective clothing. The risk of frostbite begins to increase at wind chills of -28 ºC and below (see Figure 5).

Figure 5: Advice from Environment Canada about risk of cold weather injuries and how to prevent them

Wind Chill	Risk of Frostbite	Other Health Concerns	What to Do
0 to -9	**Low**	Slight increase in discomfort	Dress warmly Stay dry
-10 to -27	**Low**	Uncomfortable Risk of hypothermia if outside for long periods without adequate protection.	Dress in layers of warm clothing, with an outer layer that is wind-resistant. Wear a hat, mittens or insulated gloves, a scarf and insulated, waterproof footwear. Stay dry. Keep active.
-28 to -39	**Risk:** exposed skin can freeze in 10 to 30 minutes	Risk of frostnip or frostbite: Check face and extremities for numbness or whiteness. Risk of hypothermia if outside for long periods without adequate clothing or shelter from wind and cold.	Dress in layers of warm clothing, with an outer layer that is wind-resistant Cover exposed skin Wear a hat, mittens or insulated gloves, a scarf, neck tube or face mask and insulated, waterproof footwear Stay dry. Keep active.
-40 to -47	**High risk:** exposed skin can freeze in 5 to 10 minutes*	High Risk of frostbite: Check face and extremities for numbness or whiteness. Risk of hypothermia if outside for long periods without adequate clothing or shelter from wind and cold.	Dress in layers of warm clothing, with an outer layer that is wind-resistant. Cover all exposed skin. Wear a hat, mittens or insulated gloves, a scarf, neck tube or face mask and insulated, waterproof footwear. Stay dry. Keep active.
-48 to -54	**Very High risk:** exposed skin can freeze in 2 to 5 minutes[1]	Very High Risk of frostbite: Check face and extremities frequently for numbness or whiteness. Serious risk of hypothermia if outside for long periods without adequate clothing or shelter from wind and cold.	Be careful. Dress very warmly in layers of clothing, with an outer layer that is wind-resistant. Cover all exposed skin Wear a hat, mittens or insulated gloves, a scarf, neck tube or face mask and insulated, waterproof footwear. Be ready to cut short or cancel outdoor activities. Stay dry. Keep active.
-55 and colder	**Extremely High risk:** exposed skin can freeze in less than 2 minutes[1]	DANGER! Outdoor conditions are hazardous.	Stay indoors.

[1] In sustained winds over 50 km/hr, frostbite can occur faster than indicated

In combination with Figure 2, the information in Figure 5 suggests that hypothermia could occur at temperatures as high as -5 °C, and that in conditions of high wind, frostbite is a possibility at -15 °C.

As shown in Figure 5, typical advice to prevent acute cold-related injury such as hypothermia and frostbite is to dress warmly, seek shelter, and stay dry. This advice may be difficult to follow for people experiencing homelessness.

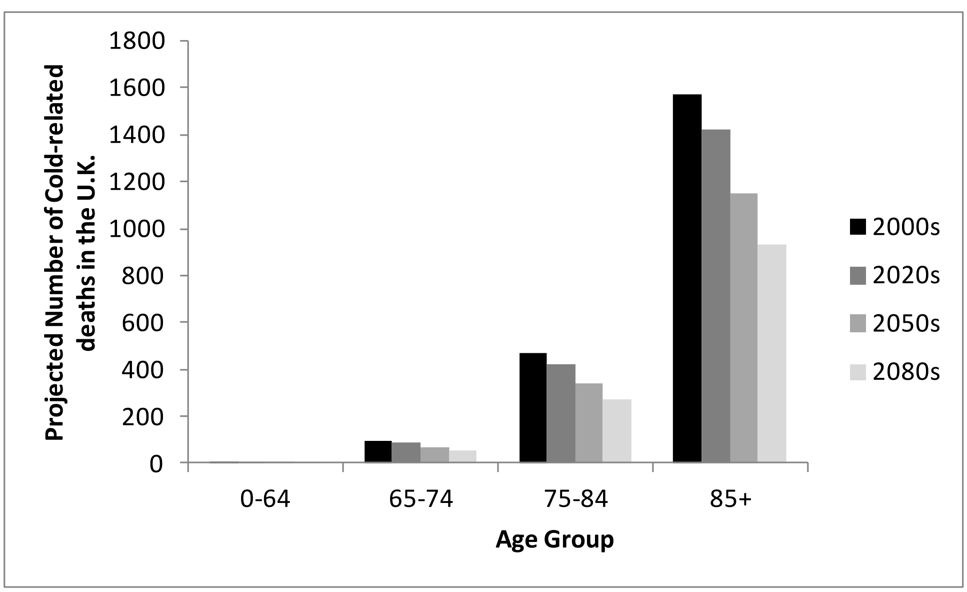
Other Health Impacts Associated with Cold Weather

Mortality

In many temperate countries there is a clear seasonal pattern to mortality with death rates being higher in the winter than in the summer. This is driven by an uptick in deaths from cardiovascular, respiratory, and circulatory diseases. When the weather gets cold, mortality tends to increase more in regions where winters are typically warmer, in populations with less home heating, and where people wear lighter clothes (Hales, 2003). The phenomenon affects Canada too: a study of 15 Canadian cities suggests that Canadians experience greater impact on mortality from cold than they do from heat (Martin et al, 2011).

The elderly may be at particular risk for cold-related mortality. A global meta-analysis concluded that during cold periods, each 1° C decrease in temperature was associated with a 1-2% increase in all-cause mortality among the elderly, with lags of up to 9 days (Yu, 2012). Research in several countries identified older age as a risk factor for all-cause and cardiovascular mortality that appears to have been precipitated by cold (O'Niell, 2003; Conlon, 2011; Lin, 2011; Phu Pin, 2011; Wu, 2011). A World Health Organization report estimated that those over 75 years of age may have an especially large winter excess of mortality of about 30% (Hales, 2003). A recent study illustrates that that when all-cause mortality attributable to cold was calculated for the U.K. population, the elderly were by far the most vulnerable population (See Figure 6) (Hajat, 2014).

Figure 6: Estimates of cold-related deaths in the UK per year, by age group (Hajat et al, 2014).



Mortality also increases within the winter season as temperature decreases. Around the world, the relationship between mortality and temperature tends to show a "U-shape", with mortality increasing when temperatures are extremely low or extremely high (McMichael, 2008). The inflection point of the "U" changes depending on the location. This reflects acclimatization – populations adapt to the conditions they are used to.

Some winter mortality increase could be due to influenza. Influenza is a common health outcome in the wintertime and can lead to premature deaths and hospitalizations among vulnerable groups, especially the elderly. However, research does not consistently find an association between ambient temperature and incidence of influenza, and cold weather effects appear to persist even when adjusting for influenza (eg., von Klot, 2012).

Periods of extreme cold weather also appear to be associated with elevated mortality. Extreme cold is often defined in terms of percentiles of observed temperatures for a particular location rather than using an absolute temperature threshold. This ensures that that the analyses capture temperatures that are relatively unusual for the local climate. In Stockholm, all-cause mortality was elevated with temperatures below the 2nd percentile (Aastrom, 2014). In China, stroke mortality was associated with both the 10th percentile and the 1st percentiles of temperature (Chen, 2013) and ischaemic heart disease mortality was 48% higher at the 1st percentile of temperature compared with the 10th percentile (Guo, 2013). Also in China, a cold spell (defined as seven days in a row with temperatures below the third percentile) was associated with a 13% increase in total short-term mortality and cardiovascular mortality elderly populations (Ma, 2013).

Some research suggests that even Northern populations that appear to be acclimatized to cold weather may be vulnerable to unusually cold conditions: in Japan, the excess mortality risk from cold was 3.47% (1.75%-5.21) when comparing the first vs. tenth percentile of temperatures (Ng, 2014). On the other hand, a study in Kasakhstan, the second coldest capital city of the world, did not find any association between temperature or apparent temperature with hypertensive disorders, ischaemic heart disease or cerebrovascular causes (Grijbovski, 2012). Of two studies conducted in Montreal, one found no association between cold weather and daily mortality (Goldberg, 2011), and the other found that mortality risk increased after cold weather for peoplediagnosed as having congestive heart failure (Kolb, 2007).

The evidence for elevated mortality related to cold is strongest for cardiac outcomes. A systematic review of the relationship between extreme temperatures and heart attack found that 8 of 12 studies that examined the winter season found a significantly increased risk of heart attack at lower temperatures (Bhaskaran, 2009). A study of 50 U.S. Cities found that cardiovascular deaths, especially those due to cardiac arrest (heart attack) were more common after extremely cold temperatures (first percentile) (Medina-Ramon, 2006). Since then, additional evidence has emerged that cold weather is linked to cardiovascular health outcomes. For example, Across 48 U.S. cities, a temperature decrease from 0 to -5° C was associated with an increased risk of cardiac death (Von Klot, 2012). In Massachusetts, a decrease in interquartile range of apparent temperature was associated with an increased risk of heart attack on the day of the cold weather and even more so two days afterwards (Madrigano, 2013). Impacts of cold weather on cardiovascular health outcomes have also been reported in China, (Guo, 2013), in Sweden, (Rocklov, 2011) and in Hungary (Toro, 2010). Among studies that examine the effect of cold on several health outcomes, the relationships are often stronger for cardiac outcomes than respiratory or other causes (eg., Ha 2009, Chan 2013; Wichmann, 2011; Lin, 2011).

Socioeconomic factors may also contribute to increased risk of cold-related mortality: a study of 7 U.S. cities found that mortality was more common among those who were black than white, and among those with less education (O'Niell, 2003).

Hospitalization
Similar patterns emerge in studies of cold-related hospitalizations. A global review of the impact of cold on morbidity found that while the measurements of temperature and health vary widely, most studies find that there is a relationship between temperature and morbidity, and that cold may have a lag effect of up to a few weeks (Ye, 2011). Research conducted since then supports these conclusions. For example, (Wichmann, 2012) found a decrease of 9% in admission rate for heart attack with each 6-7° C increase in apparent temperature in Copenhagen. In a separate Copenhagen study, cold weather was associated with increases in admissions for cardiovascular, respiratory, and cerebrovascular causes among elderly men and among those with higher socioeconomic status (Wichmann 2011). In Shanghai, cold spells were associated with a 38% increase in total hospital admissions, a 33% increase in cardiovascular admissions, and a 32% increase in respiratory admissions (Ma, 2011). Among elderly groups, excess hospitalization in winter appears to be higher among those in institutional settings as compared with seniors living in the community (Chau, 2012).

A potential explanation for the impact of cold weather on cardiovascular health, and possibly also for stroke, is that blood pressure increases in times of cold weather (Halonen, 2011). This occurs because blood vessels tend to constrict to protect the body's core temperature.

Other Chronic Health Conditions
A review of evidence for an impact of cold exposure on stroke found mixed results (McArthur 2010). Since then, a study in China found that risk of stroke increased with the 10th percentile of temperatures, with a stronger association during periods of extreme cold (first percentile) (Chen, 2013), and a study in Japan found that risk of stroke death increased with decreasing temperatures for those with hyperglycemia.

Other health impacts that may be associated with cold weather include exacerbation of chronic obstructive pulmonary disease (COPD) symptoms (Tseng, 2013), increased intensity of chronic pelvic paid symptoms (Hedelin, 2012), increase in respiratory symptoms generally (Harju, 2010), and exacerbation of childhood asthma (Guo, 2012; Xu, 2013). Children exposed to cold may also be at risk of more infectious respiratory conditions and allergic conditions such as eczema (Xu, 2012).

There has also been some suggestion that large swings in temperature may lead to more emergency department admissions for heart failure (Qiu, 2013) and for childhood asthma (Xu, 2013). This may become an increasingly important factor in the future because climate change predictions suggest that weather patterns will become increasingly variable and unpredictable.

The research on how cold affects mortality and hospitalizations consistently suggests that the impacts are not immediate, and are often not observed on the same day as the cold weather. In fact, many studies suggest that mortality and hospitalizations form cold may have lag effects of up to a few weeks (eg., Guo, 2011; Ye, 2012).

Indicators for Cold Weather

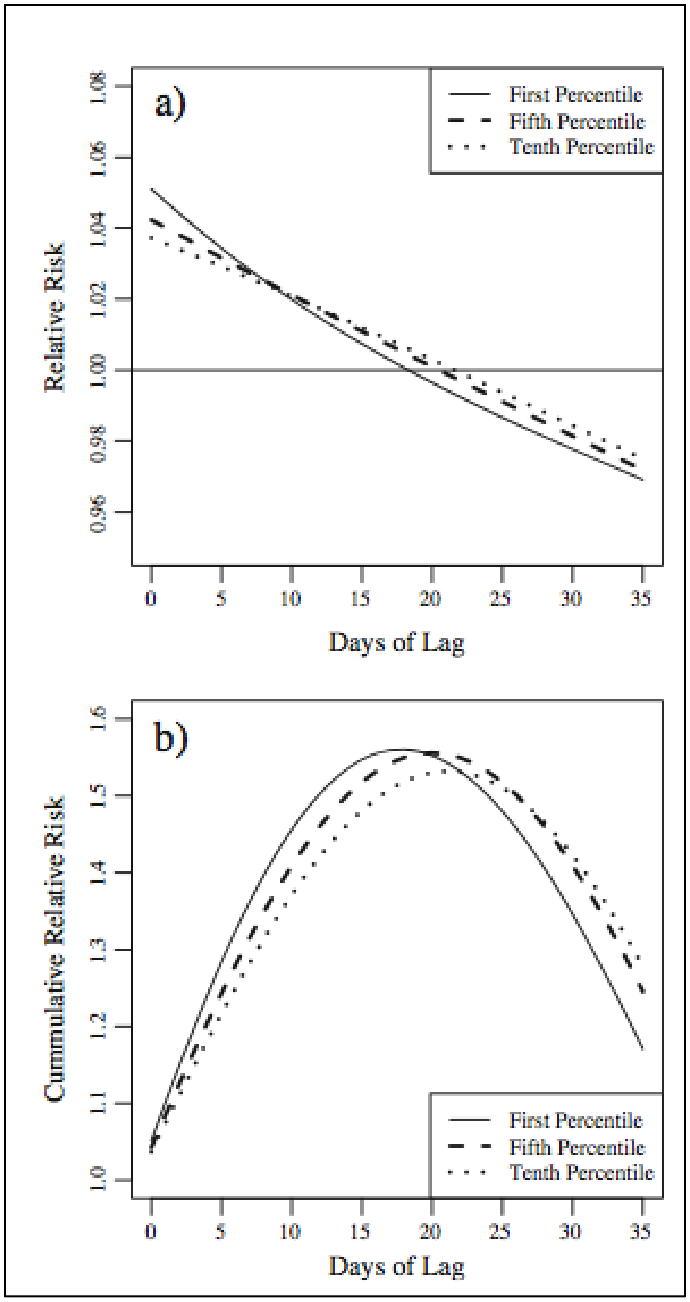
It is very difficult to establish thresholds of effect for these relationships. Not only is the point of inflection in the temperature-outcome curve dependent on local climatic conditions and populations, but the metrics used to assess the impact of cold weather vary tremendously across the research studies that are available. While some researchers identify a linear relationship between exposure to cold and a one degree change in temperature, or an interquartile change in temperature, others use the lowest percentiles of temperature to establish the impacts of extreme cold. There appears to be no common reference point for which percentile represents "extreme cold". Some use daily minimum temperatures while others use maximum or daily averages. Still others use apparent temperature, which incorporates a measure of humidity. Some research suggests that average daily temperature is the best predictor of mortality, while others suggest that there is no one temperature measure that is better than others (Barnett, 2010).

Findings from the relatively little research available on the impact of wind chill on these health outcomes are mixed. In some cases, wind chill was found to be a better predictor of mortality than temperature alone (Kunst 1994; Eng 2000). Other research suggests that changes in wind chill are about as good as changes in temperature for predicting a change in mortality (Carder, 2005). In some cases, researchers found wind chill to be better that temperature for some specific outcomes, including cardiovascular mortality and hospitalization for stroke. However, there seems to be little information on whether the threshold at which effects begin to become apparent would be different from the temperature thresholds.

Toronto

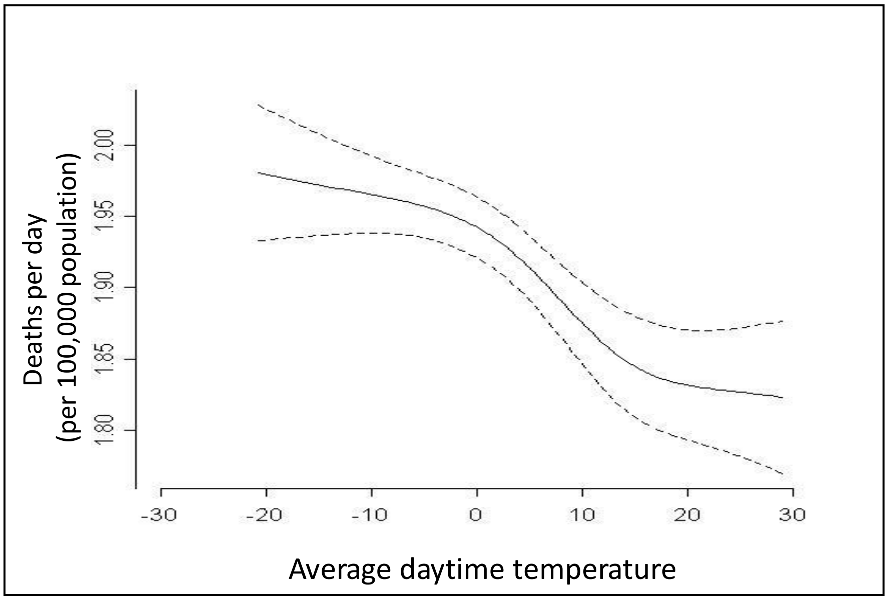
A historical analysis of weather and all-cause mortality for the City of Toronto concluded that cold contributes to 105 premature deaths each year in the City (Toronto Public Health, 2005). Figure 7 shows findings for Toronto from a paper that examined the relationships between temperature, mortality, and lag effects (Martin et al, 2011). Part (a) shows the relative risk of mortality for cold temperatures (first, fifth, and tenth percentiles) and indicates that the greatest risk of death may occur on the day of exposure to cold weather, decreasing gradually thereafter. Part (b) shows the cumulative risk of mortality, which appears to peak 15-20 days after exposure to cold weather.

Figure 7: Relationships between temperature, lag, and risk of mortality for Toronto From (Martin, 2011).



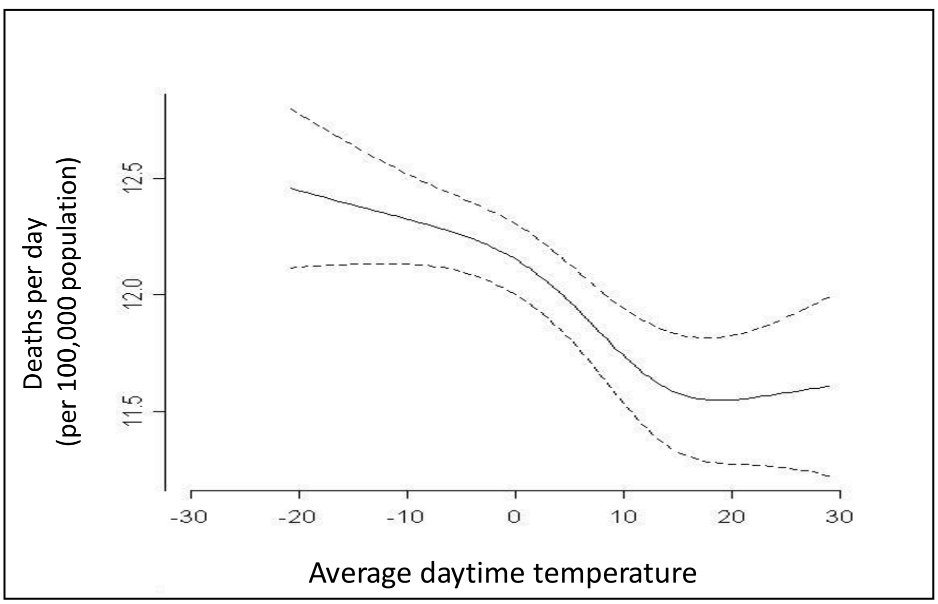
A separate analysis of historical (1979-2004) temperature and mortality data for the City of Toronto shows the relationship between outdoor temperature and mortality (Murti, 2009). The results are based on a 3-day lag and suggest that as the daily average temperatures decrease, the risk of mortality increases. Figure 8 and Figure 9 illustrate the findings for the general population and those aged 65+, respectively. The risk of death for the older age group (Figure 9) is about six times the risk found for all ages (Figure 8). The lag considered in this analysis was three days; this relationship is not observed for analyses of shorter lags. Given that research elsewhere has found impacts at lags of up to two weeks, these figures may underestimate the magnitude of the cold weather risk. As well, the analysis is based on average rather than minimum temperatures, and so may miss impacts of particularly cold spells.

Figure 8: Deaths per day in Toronto (all ages)



Data Source: IntelliHEALTH and Environment Canada
Notes: Based on a three-day lag and data from 1979-2004. Dashed lines denote 95% confidence intervals.

Figure 9: Deaths per day in Toronto residents 65 and older



Data Source: IntelliHEALTH and Environment Canada
Notes: Based on a three-day lag and data from 1979-2004. Dashed lines denote 95% confidence intervals.

Public Health Ontario is currently conducting a more rigorous analysis of the relationships between temperature and morbidity and mortality for various regions across Ontario, including

Toronto. The analysis will examine the effects of temperature and windchill, and explore possible thresholds for effect. Preliminary findings suggest that exposure to cold weather increases the risk of cardiovascular health outcomes in Toronto, and that the effect occurs with a substantial time lag (Chen, 2014). This research is expected to be finalized by the end of 2014.

Other Health Effects Associated with Cold Weather

Cold weather conditions can also be associated with other types of health impacts. For example, icy and snowy weather can increase the number of slips and falls, leading to injuries. During wintertime power outages, cases of carbon monoxide poisoning often increase, as people use devices such as barbeques or portable generators indoors for cooking or heating. As well, there have been reports from the United States of snow blocking car exhaust vents, leading to buildup of carbon monoxide in the vehicles when they were started up (Johnson-Arbor, 2014).

Cold weather and climate change

Climate change predictions for Toronto suggest that winters may be less cold in the future. Some argue that this should result in fewer cold-related health impacts (Patz, 2000). More recently, other scientists argue that the burden of disease from cold may not diminish in the coming decades, as the population ages, increasing the pool of at-risk people. A UK analysis found that although the climate is warming, the contribution of population growth and ageing means that the numbers of deaths from cold weather will increase into the 2020s before declining in the 2050s and beyond (Hajat et al, 2014). As well, climate change is associated with volatile swings in weather, meaning that while cold may become less common overall, unusual cold spells may occur more frequently. In a population that has become less acclimatized to cold, these unusual weather events could have a greater impact when they do occur (Ebi, 2013; Woodward, 2014).

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