Climate change and the new normal for cardiorespiratory disease

TK Takaro, SB Henderson. Climate change and the new normal for cardiorespiratory disease. Can Respir J 2015;22(1):52-54.

Climate change is already affecting the cardiorespiratory health of populations around the world, and these impacts are expected to increase. The present overview serves as a primer for respirologists who are concerned about how these profound environmental changes affect their patients. The authors consider recent peer-reviewed literature with a focus on climate interactions with air pollution. They do not discuss in detail cardiorespiratory health effects for which the potential link to climate change is poorly understood. For example, pneumonia and influenza, which affect >500 million people per year, are not addressed, although clear seasonal variation suggests climate-related effects. Additionally, large global health impacts in low-resource countries, including migration precipitated by environmental change, are omitted. The major cardiorespiratory health impacts addressed are due to heat, air pollution and wildfires, shifts in allergens and infectious diseases along with respiratory impacts from flooding. Personal and societal choices about carbon use and fossil energy infrastructure should be informed by their impacts on health, and respirologists can play an important role in this discussion.

Key Words: Air pollution; Cardiorespiratory disease; Climate change; Floods; Forest fires; Heat effects

Wildfires cause episodes of the worst air pollution that most Canadians will ever experience. Higher temperatures and increasing drought contribute to greater wildfire risk, and recent analyses by the Canadian Forest Service suggest that annual average fire activity could double by the end of the century due to climatic changes (19). This increase in fire risk is driven by warmer spring and summer temperatures, reduced precipitation and snowpack, earlier snowmelt and prolonged summer fire seasons at higher elevations (20). Wildfires also put forests at risk for new and more widespread threats that further increase fire risk. For example, the mountain pine beetle has devastated lodgepole pine in British Columbia (BC) and may threaten forests at risk for new and more widespread threats that further increase fire risk. The 2014 fire season was extreme throughout Western Canada, with >4.2 million hectares burned in >3500 fires west of Manitoba. While 40% of these fires were in BC, 80% of the burned area was in the Northwest Territories, where much of the population was exposed to dense smoke for extended periods of time.

Wildfire smoke is a complex mixture of particulates and gases that are known to have acute and chronic health effects (22,23). Most of the epidemiological research focuses on increased PM2.5 during smoke episodes, which has been associated with a spectrum of acute respiratory impacts (24,25) including symptoms of pain, irritation, cough and premature death. Individuals with COPD, CVD, diabetes and chronic ozone exposures are at particular risk (15). The highest burden of these effects is disproportionately distributed to low-income countries, which affect >500 million people per year, are not addressed, although clear seasonal variation suggests climate-related effects. Additionally, large global health impacts in low-resource countries, including migration precipitated by environmental change, are omitted. The major cardiorespiratory health impacts addressed are due to heat, air pollution and wildfires, shifts in allergens and infectious diseases along with respiratory impacts from flooding. Personal and societal choices about carbon use and fossil energy infrastructure should be informed by their impacts on health, and respirologists can play an important role in this discussion.

Key Words: Air pollution; Cardiorespiratory disease; Climate change; Floods; Forest fires; Heat effects

TK Takaro, SB Henderson. Climate change and the new normal for cardiorespiratory disease. Can Respir J 2015;22(1):52-54.

Climate change is already affecting the cardiorespiratory health of populations around the world, and these impacts are expected to increase. The present overview serves as a primer for respirologists who are concerned about how these profound environmental changes affect their patients. The authors consider recent peer-reviewed literature with a focus on climate interactions with air pollution. They do not discuss in detail cardiorespiratory health effects for which the potential link to climate change is poorly understood. For example, pneumonia and influenza, which affect >500 million people per year, are not addressed, although clear seasonal variation suggests climate-related effects. Additionally, large global health impacts in low-resource countries, including migration precipitated by environmental change, are omitted. The major cardiorespiratory health impacts addressed are due to heat, air pollution and wildfires, shifts in allergens and infectious diseases along with respiratory impacts from flooding. Personal and societal choices about carbon use and fossil energy infrastructure should be informed by their impacts on health, and respirologists can play an important role in this discussion.

Key Words: Air pollution; Cardiorespiratory disease; Climate change; Floods; Forest fires; Heat effects

The global environment is undergoing profound change due to increases in temperatures and changes in the hydrological cycle (1). Climate change is a serious public health threat, both globally and nationally. In a recent update, the WHO estimated that 250,000 additional deaths per year will be caused by climate change between 2030 and 2050 (2). In addition to increased mortality, millions of disability-affected life-years will be lost annually due to climate change impacts over the previous three decades (3). Although the burden of these effects is disproportionately distributed to low-income countries, the health of the Canadian population is also affected. Although more exhaustive reviews have summarized and described the observed and potential impacts (4), our objective is to provide a brief overview from a Canadian perspective.

A growing body of epidemiological literature specifically associates climate change with changing distributions of cardiorespiratory disease and mortality (1,4-8), which includes both direct and indirect effects. The indirect effects include shifts in allergen load, changes in the distribution of vector-borne illnesses, and societal disruptions that can change risk factors for populations affected by extreme events, sea level rise and forced migration (9-11). The more direct effects include heat-related exacerbations of conditions such as asthma, chronic obstructive pulmonary disease (COPD) and cardiovascular disease (CVD), increases in hazardous air pollution days from ozone and particulate matter, and mortality and morbidity from extreme weather events and their aftermaths (9,10,12). We highlight some specific examples of impacts that should be considered by Canadian respirologists.

AIR POLLUTION (ASTHMA AND COPD)

Increasing atmospheric temperatures and related meteorological effects can worsen ground-level pollution, most notably ozone (12-14), leading to diminished lung function, increased health care utilization and the need for continued medication. For example, during the 1990s, BC saw a decrease in ozone levels due to a decrease in anthropogenic emissions, but with increased air temperatures, ozone levels increased again (15). Climate change is expected to increase ozone levels in BC, leading to increased respiratory effects (15). In addition, increased temperatures are expected to increase the frequency of heat waves, which are known to increase hospital admissions and emergency room visits for respiratory and cardiovascular conditions (16). Similarly, increased temperatures are expected to lead to increased instances of wildfire, which can significantly increase air pollution levels (17,18). The predicted increase in temperatures threatens our ability to meet health-based air quality standards in the future.

WILDFIRES (ALL RESPIRATORY AND CVD)

Wildfires cause episodes of the worst air pollution that most Canadians will ever experience. Higher temperatures and increasing drought contribute to greater wildfire risk, and recent analyses by the Canadian Forest Service suggest that annual average fire activity could double by the end of the century due to climatic changes (19). This increase in fire risk is driven by warmer spring and summer temperatures, reduced precipitation and snowpack, earlier snowmelt and prolonged summer fire seasons at higher elevations (20). Wildfires also put forests at risk for new and more widespread threats that further increase fire risk. For example, the mountain pine beetle has devastated lodgepole pine in British Columbia (BC) and may threaten forests at risk for new and more widespread threats that further increase fire risk. The 2014 fire season was extreme throughout Western Canada, with >4.2 million hectares burned in >3500 fires west of Manitoba. While 40% of these fires were in BC, 80% of the burned area was in the Northwest Territories, where much of the population was exposed to dense smoke for extended periods of time.

Wildfire smoke is a complex mixture of particulates and gases that are known to have acute and chronic health effects (22,23). Most of the epidemiological research focuses on increased PM2.5 during smoke episodes, which has been associated with a spectrum of acute respiratory impacts (24,25) including symptoms of pain, irritation, cough and...
phlegm (26), increases in medications dispensed (27), outpatien-
t visits (28), emergency room visits (29), hospital admissions (30) 
and mortality (31). Further evidence suggests that babies in the womb
during smoke events are at higher risk for low birth weight (32), with
lifelong health implications. There have not been any studies investigat-
ing the long-term impacts of wildfire smoke exposure on children and
adults. However, we know from the literature on urban air pollution that
increased annual average PM2.5 concentrations are associated with
increased rates of chronic respiratory and CVDs in the population (33).
As emissions from transportation and industrial sources come under bet-
ter control, we expect that wildfire smoke will play an increasingly
important role in lifetime exposure to PM2.5 and, therefore, in the
development of chronic diseases (34). One recent worldwide study esti-
mated that an average of 339,000 deaths could be attributed to the acute
and chronic impacts of wildfire smoke each year (35). These health
threats could increase in the future as climate change exacerbates wild-
fire risks in Canada and around the world (36).

CHANGES IN POLLEN RELEASES (ASTHMA AND ALLERGIC RHINITIS)
Aero-allergenic plant pollen production and distribution is impacted by
climate change, with several-fold increases in tree, grass and weed
pollen demonstrated under higher carbon dioxide concentrations
(37,38) and with extended growing seasons. In midwestern North
America between 1995 and 2009, ragweed pollen production increased up
to 27 pollination days over the year (39). Increases in ambient pollen
concentrations are associated with higher rates of allergic sensitiza-
tion, higher health care utilization and large increases in over-the-
counter allergy medication sales (4.12,40-45). Drought conditions are
also predicted to increase, and can worsen these impacts as more pol-
len, dust and particulates become airborne in dry conditions.

HEATWAVES (COPD, CVD)
Over the past 60 years, average annual temperatures in Canada have
increased by >1.5°C (6). During multi-day heatwave periods, addi-
tional deaths can range into the tens of thousands, as in the 2003
European and 2010 Russian heatwaves, among other notable events.
Extreme heat increases short-term premature mortality and morbidity
from a variety of causes, including those directly heat-related (heat
stroke, heat syncope, heat edema, etc) and a range of cardiovascular,
respiratory, kidney and other illnesses (7,46,47). Increased tempera-
ture variability can also increase mortality among elderly patients
(48), even in typically moderate climates such as Vancouver, BC (49).

STORMS, FLOODING AND MOULD EXPOSURE
Climate change is predicted to increase the intensity of storm events.
Thunderstorm activity has been associated with asthma exacerba-
tions in North America, Europe and Australia (50,51) due to the
breakage and wide dispersion of pollens by the turbulent atmosphere.
More intense storms also lead to increased precipitation, which has
been observed across most parts of Canada over the past 60 years
(6). More precipitation will also lead to more flooding (52), which
threatens health infrastructure, even in wealthy countries. Patients
requiring mechanical ventilation and intensive care are particularly
vulnerable due to the challenges posed by evacuation and power out-
ages (53). Multiple health care facilities were evacuated during the
unprecedented 2013 floods in Alberta (www.directo.ca/presenta-
tions/20140107/20140107_tom_watts.pdf), although specific impacts
of the floods have not been published to date. Resource-poor facilities
are likely to be even more vulnerable to extreme weather threats.

Floods and persistent dampness in homes can promote microbial
growth, particularly moulds. High indoor/outdoor mould ratios were
observed in the months following Hurricanes Rita and Katrina, indi-
cating the potential for high indoor exposures (54). Mould levels may
increase under climate change due to increased moisture in building
materials and indoor dampness, increased temperatures and elevated
carbon dioxide concentrations that encourage growth (54,55-57). In
immune-competent individuals, respiratory illness associated with
mould exposure is due to fungal elements that may be allergens or
respiratory irritants, leading to exacerbations of allergic rhinitis and
asthma (58). In immune-compromised individuals or those with con-
comitant pulmonary disease, fulminant fungal infections, such as
aspergillosis, may ensue (59).

MITIGATION AND CARDIORESPIRATORY HEALTH
Mitigation of greenhouse gas (GHG) emissions to reduce future
impacts is a critical challenge for society; however, adaptation to the
inevitable increases in temperature will also be required. There is sig-
ificant uncertainty about the range of projected average surface tem-
peratures in the future; this uncertainty increases with efforts to
predict more local changes (1). There is even greater uncertainty in
predicting precipitation (1). Some of this is due to the fact that we
cannot accurately project future human behaviour that drives GHG
emissions. Although societal efforts to achieve meaningful GHG
reductions targets will be challenging, the benefits to cardiorespiratory
health are significant and can be more immediate and tangible than
reductions in GHGs (60). These include reduction in health-harming
copollutants emitted with GHGs, and reduction in natural hazards
such as wildfires and floods. The improvements in health have already
been observed in indoor dampness and moulds, such as increased rates
of respiratory illness (59) and asthma exacerbations (61). Mould
levels may increase under climate change due to increased moisture in
building interiors (54,55). Mould levels may also increase under cli-
mate change due to increased moisture in building interiors (54,55).

ACKNOWLEDGEMENTS:
The authors thank Kim Knowlton and John R Balmer for their bibliographies, and Agnes T Black for editing assistance.

REFERENCES
1. Allan RP, Soden BJ. Atmospheric warming and the amplification of precipitation extremes. Science 2008;321:1484-1.
2. WHO. Quantitative risk assessment of the effects of climate change on selected causes of death. 2007:1-50. Geneva: WHO, 2014.
3. Parz JA, Campbell-Lendrum D, Holloway T, Foley JA. Impact of regional climate change on human health. Nature 2005;438:310-7.
4. Pinkerton KE, Rom WN, Akpinar-Eliç M, et al. An official American Thoracic Society workshop report: Climate change and human health.
Proc Am Thorac Soc 2011;8:1-3.
5. Field CB, Barros V, Stocker TF, et al; IPCC, eds. Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. IPCC; 2012:1-382.
6. Warren FJ, Lemmen DS, eds. Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation. Ottawa: Government of Canada, 2014:286.
7. Ye X, Wolf R, Yu W, Vaneckova P, Pan X, Tong S. Ambient temperature and morbidity: A review of epidemiological evidence. Environ Health Perspect 2012;120:19-28.

DISCLOSURES: The authors have no conflicts of interest to declare. 

CONCLUSIONS
It is difficult for individuals to feel empowered in the face of some-
thing as vast and daunting as climate change. We can make personal
choices and contribute to community efforts, but the challenge will
continue to involve large energy infrastructure and be global in scope
(63). Nevertheless, respirologists can play an important role because
climate change will significantly affect cardiorespiratory health and
is, therefore, an issue of considerable importance to individuals and
governments. To date, human health, particularly cardiorespiratory
health, has not been central to the climate change and energy dia-
logue in Canada. Many Canadians may not be well informed about
direct threats to their cardiorespiratory health from the increased
wildfires, hot weather events, air pollution, flooding, mould and
longer pollen seasons that are predicted over the coming decades.
Respirologists have a unique opportunity to build public interest in
this issue by making it relevant to something in which most individ-
uals have profound interest: protecting the health of their families
now and for future generations.
