The Potential Impact of Climate-Related Risks on Critical Illness Claims in Hong Kong in 2050

Non-optimal temperature and air pollution

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Key takeaways

Given the importance of the critical illness (CI) market in Hong Kong, we have investigated how climate-related risks of non-optimal temperatures (heat and cold) and air pollution (PM2.5 and ozone) may impact the following causes of CI claims in Hong Kong by 2050:

- Breast cancer
- Colorectal cancer
- Lung cancer
- Heart attack
- Stroke

Our assessment is based on the IPCC SSP2-4.5 scenario, although we have also considered how air pollution impacts may differ under Hong Kong's Clean Air Plan.

We find that, apart from a small impact from extreme heat on the incidence of male heart attacks, only the expected reduction in long-term exposure to PM2.5 air pollution has a material impact on overall CI claims.

By 2050, overall CI rates could decrease by around 1% under the SSP2-4.5 scenario.

In a scenario in which greater air pollution improvements might be achieved under Hong Kong's Clean Air Plan, overall CI rates could decrease by around 4%.

However, we must recognize that there is significant uncertainty in how climate-related risks may change between now and 2050 and in how such changes may affect disease incidence.

Introduction

Given the importance of Hong Kong as a market for CI insurance, RGA reviewed the academic literature to assess the possible impact of climate change on future CI claims in Hong Kong.

This report considers two key quantifiable climate-related risks identified by previous RGA research in the markets of Hong Kong, South Africa, the UK, and Canada:

- Non-optimal temperature (heat and cold)
- Air pollution (PM2.5 and ozone)

We evaluate the potential impact in 2050 under the IPCC SSP2-4.5 scenario. For air pollution impacts, we also consider the potential impact under Hong Kong's clean air strategy.

We focus on incidence of the following morbidities, which are leading causes of CI claims:

- Breast cancer
- Colorectal cancer
- Lung cancer
- Heart attack
- Stroke

For breast, colorectal, and lung cancer incidence, we analyze the association with long-term exposure to non-optimal temperatures and air pollution.

For incidence of heart attack and stroke, we examine the association with short-term and long-term exposure to non-optimal temperatures and air pollution.

Our approach:

- Review the academic literature to identify the associations between incidence risk for these five key causes of CI claims and exposure to non-optimal temperatures and air pollution.
- Estimate the projected change in non-optimal temperatures and air pollution in Hong Kong by 2050.
- Apply the incidence-exposure relationship to the projected change in exposure to non-optimal temperatures and air pollution by 2050 to estimate the impact on CI claims.

Incidence-exposure associations

The following associations were established in the academic literature. Full details are shown in the Appendix.

- More periods of extreme heat will increase incidence of heart attacks and strokes.
- Fewer periods of extreme cold will reduce incidence of heart attacks and strokes.
- Reductions in short-term peaks in PM2.5 will reduce the incidence of heart attacks and strokes.
- Long-term reductions in PM2.5 levels will reduce breast and lung cancer incidence, as well as the incidence of heart attacks and strokes.
- Reductions in short-term peaks in ozone will reduce the incidence of heart attacks and strokes.
- Long-term reductions in ozone levels will reduce the incidence of strokes.

Risk	Breast cancer	Lung cancer	Heart attack	Stroke
Increase in extreme heat			↑	↑
Reduction in extreme cold			↓	↓
Short-term reduction in PM2.5			↓	↓
Long-term reduction in PM2.5	↓	↓	↓	↓
Short-term reduction in ozone			↓	↓
Long-term reduction in ozone				↓

Projected changes in temperature and air pollution in Hong Kong by 2050

We estimate how temperature and air pollution may change in Hong Kong by 2050 under the SSP2-4.5 scenario. For air pollution, we also estimate how this may change under Hong Kong's Clean Air Plan.

Extreme temperatures

Based on Tse et al. (2024), the number of very hot days (high temperature of 33°C or above) in Hong Kong is projected to increase by 2050, and we might expect to see around 25 additional very hot days under SSP2-4.5.

The number of cold days (low temperature of 12°C or less) in Hong Kong is projected to decrease by 2050, and we can expect to see around three fewer cold days.

PM2.5 air pollution

Based on data published by the Hong Kong Environmental Protection Department,[1] the average annual PM2.5 level across all monitoring stations in 2024 was 15.9 μg/m³.

We consider potential changes to PM2.5 levels by 2050 under two scenarios:

- Projections made by the IPCC under SSP2-4.5
- Estimates of PM2.5 reductions that might be achieved under Hong Kong's Clean Air Plan

SSP2-4.5

Under SSP2-4.5, PM2.5 levels in East Asia (which includes Hong Kong)[2] are projected to fall by around 2.2 μg/m³ between 2022 and 2052.[3] Applying this to Hong Kong, based on the average annual PM2.5 level across all monitoring stations in 2024, would result in a reduction of around 15%.

Clean Air Plan

The Clear Air Plan for Hong Kong, published in June 2021, aims to:

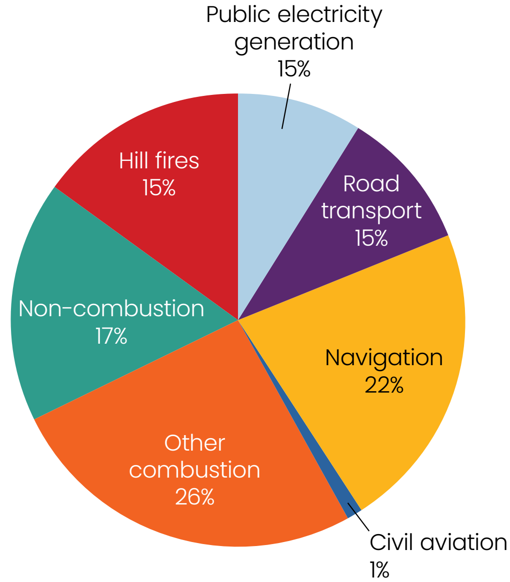
- Transform Hong Kong into a livable city – with air quality comparable to major international cities – by 2035
- Achieve air quality targets established by the World Health Organization (WHO) guidelines

The WHO 2021 air quality guideline (AQG) for annual PM2.5 is 5 μg/m³. To meet this target, average PM2.5 levels in 2024 would need to diminish by around 70%.

However, the Hong Kong Environmental Protection Department's 2023 emissions inventory[4] indicates that approximately 15% of PM2.5 air pollution originates from hill fires. As a result, PM2.5 from hill fires alone would account for around half of the WHO AQG 2021 limit, and hill fires are a difficult source of PM2.5 air pollution to control.

We assume that air pollution levels in Hong Kong might decline approximately 50% by 2050 under the clean air strategy.

Sources of PM2.5 air pollution, Hong Kong, 2023



Data source: 2023 Hong Kong Emission Inventory Report

Ozone

Based on data published by the Hong Kong Environmental Protection Department,[5] the average ozone level across all monitoring stations in 2024 was 50.4 μg/m³.

The maximum eight-hour average ozone level in 2024 was 250 μg/m³, which occurred in September at the Tuen Mun air monitoring station. Averaged across all monitoring stations, the maximum eight-hour average ozone level in 2024 was 203 μg/m³.

SSP2-4.5

Under SSP2-4.5, annual mean surface ozone levels in East Asia (which includes Hong Kong)[6] are projected to reduce by around 0.9 ppb between 2024 and 2050.[7] This is broadly equivalent to 1.8 μg/m³. Based on the average annual ozone level in Hong Kong in 2024, this would be a reduction of around 4%.

Clean Air Plan

The WHO 2021 AQG target for eight-hour ozone is 100 μg/m³, with interim targets of 160 μg/m3 and 120 μg/m³. Hong Kong's current Air Quality Objective (AQO) for eight-hour ozone is 160 μg/m³, in line with the higher of the WHO's interim targets.

If the current AQO were achieved by 2050, this would be a reduction of around one-fifth, or 40 μg/m³, relative to the 2024 maximum eight-hour ozone level averaged across all monitoring stations.

Impact on critical illness claims in 2050

To estimate the potential impact on CI claims in Hong Kong in 2050, we apply the incidence-exposure associations identified in the academic literature to the potential change in exposure in each climate-related risk in Hong Kong in 2050.

For example:

- Under SSP2-4.5, we may see 25 extra days of extreme heat in 2050.
- The risk of heart attacks might increase by 16% on each of these extreme heat days.
- A 16% increase in heart attack risk over 25 days is equivalent to an annual increase in the incidence of heart attacks of around 1%.
- Heart attacks account for approximately 9% of claims for males, so the impact of extreme heat on heart attacks would increase overall CI claims by around 0.1%.

Using this approach, we find that, apart from a small impact from extreme heat on the incidence of male heart attacks, only the reduction in long-term exposure to PM2.5 is expected to have a meaningful impact on overall CI claims.

All other associations identified in the academic literature had an immaterial impact on overall CI claims:

- Periods of extreme heat and long-term reductions in ozone had an immaterial impact on strokes.
- Periods of extreme cold, short-term peaks in PM2.5, and reductions in short-term peaks in ozone had an immaterial impact on heart attacks and strokes.

The following table summarizes the estimated impacts of each climate-related risk on overall CI claims in 2050.

Potential impact on overall critical illness claims in 2050				
	SSP2-4.5		Clean Air Plan	
	Males	Females	Males	Females
Extreme heat				
Heart attack	0.1%	–	0.1%	–
PM2.5 long term				
Breast cancer		(0.8)%		(2.8)%
Lung cancer	(0.8)%	(0.3)%	(3.0)%	(1.2)%
Heart attack	(0.2)%	–	(0.6)%	(0.1)%
Stroke	(0.1)%	(0.1)%	(0.6)%	(0.2)%
Total	**(1.0)%**	**(1.2)%**	**(4.1)%**	**(4.3)%**

The Clean Air Plan, if achieved, could lead to a meaningful reduction in CI claims for cancers.

Caveats

In this report, we have considered how changes in climate-related risks of heat, cold, PM2.5 air pollution, and ozone may impact the incidence of key causes of CI claims in Hong Kong by 2050.

There is significant uncertainty in how these climate-related risks may change between now and 2050 and in how such changes may affect disease incidence.

There are uncertainties in the actions governments and society will take to transition to a lower-carbon economy. There are also uncertainties in climate science and our understanding of how the climate will develop in response to mitigation attempts.

We have considered the impact of each risk in isolation, but reality is more complex; interactions between risks increase uncertainty. The impact of risks in combination may be greater than the sum of each individual risk's impact.

The academic literature is inconclusive for some combinations of risk and disease incidence. Some researchers find a statistically significant association, but others do not. Further research is required. In these cases, we have assumed there is no association because one has not been established, but this may underestimate the impact, if further research establishes an association.

We have assumed that research results from studies around the world can be generalized and would apply in Hong Kong. This may not hold true.

Most academic research does not allow for the adaptation we likely will see as society works to manage the impacts of climate change. Note that the scope for adaptation is generally greatest for higher socioeconomic groups.

We have considered two scenarios over the period to 2050. The impacts may differ over longer periods or alternative scenarios.

There are other climate-related risks and causes of critical illness claims that we have not covered in this report. In addition, this report considers climate change in isolation and does not take into account other drivers of critical illness trends, such as changes in screening, awareness, diagnosis, medical practice or population risk factors, which may have a material impact on future incidence..

Appendix

In this Appendix, we set out the associations that have been established in the academic literature between non-optimal temperatures and air pollution in the incidence of:

- Breast cancer
- Colorectal cancer
- Lung cancer
- Heart attacks
- Stroke

We have also set out the exposure-response relationship used for the illustration set out in this report.

For brevity, we have omitted incidence-exposure relationships in which no association has been established in the academic literature or where the literature is inconclusive or contradictory.

Breast cancer incidence and PM2.5 air pollution

In the systematic review by Tippila et al. (2024), 15 out of 18 studies reported a significant association between PM2.5 exposure and breast cancer incidence over the long term.

This is supported by White et al. (2024).

We assume that changes to PM2.5 exposure will impact breast cancer incidence over the long term.

We assume that a 10 µg/m3 increase in PM2.5 is associated with a relative risk of 1.08, which is within the range of estimates noted by Tippila et al. (2024) and in line with the results of White et al. (2024).

Lung cancer incidence and PM2.5 air pollution

A meta-analysis by Huang et al. (2017) of nine prior studies found a significant association between exposure to PM2.5 and lung cancer incidence.

Huang et al. (2021a) found a significant association between PM2.5 and the risk of developing lung cancer for never-smokers in Taiwan.

Huang et al. (2021b) found a significant association between the risk of lung cancer and PM2.5 based on data from the UK Biobank.

We assumed that a 10 µg/m3 increase in PM2.5 is associated with a relative risk of around 1.23, which is the average result from Huang et al. (2017) for developed countries and Huang et al. (2021a).

Note that the effect size found in Huang et al. (2021b) was more than 3x that found in any previous study, so we have disregarded this in developing the assumption in this report.

Heart attack incidence and temperature

Short-term

Sun et al. (2018) noted previous studies suggested that ambient temperature was associated with heart attack (also referred to as myocardial infarction or MI), although consistency among those investigations was lacking. Their meta-analysis found that short-term exposure to both cold and heat was associated with an increased risk of hospitalization for heart attack over the short term.

Rowland et al. (2020) found an increase in temperature was associated with an increased risk of MI with a six-hour lag but that a decrease in temperature was associated with a decreased risk of MI. They expressed some surprise at the protective effect of lower temperatures and speculate that lower temperatures may have a delayed effect on MI risk.

Ni et al. (2025) found that an upward temperature shift (a rise in temperature relative to the preceding seven-day average) was associated with an increased risk of MI at 0 days lag. A downward temperature shift was associated with a decreased risk of MI at 0 days lag but an increased risk of MI for a two-day lag.

Krasnov et al. (2025) found no association between MI and either mean, maximal, or minimal temperatures over lags of 0-6 days. They found an association between the diurnal temperature range (DTR, the difference between daily maximum and minimum temperatures) and MI, with a smaller DTR being associated with higher odds of MI. They also found that a higher DTR was associated with higher odds of MI, but this result was not statistically significant. They note that smaller DTR is more common on colder days.

We adopt the results from the meta-analysis of Sun et al. (2018) and assumed that a 1°C increase in temperature is associated with a relative risk of 1.016, and a 1°C decrease in temperature is associated with a relative risk of 1.014.

Long term

It is well established that cardiovascular events are seasonal and occur more often in winter than in summer.

Kuzmenko et al. (2022) found that the severity of this seasonality of MI depends on the climate of a region. The following climate characteristics increase the risk of MI in winter compared to summer:

- Small differences between winter and summer temperatures
- Small differences in atmospheric pressure between winter and summer
- Small differences in the partial density of oxygen in the air between winter and summer
- Air humidity in winter that is higher than in summer

In regions with the opposite characteristics, the increased risk of MI in winter compared to summer was not significant.

The difference between winter and summer temperatures tends to increase at higher latitudes, although it is also affected by proximity to oceans and ocean currents.

Atmospheric pressure is usually higher in winter than in summer. The temperate zone of Europe tends to experience small changes in atmospheric pressure between winter and summer. In contrast, the regions of East Asia and the Middle East tend to see larger differences.

The partial density of oxygen is an indication of oxygen levels in the air and depends on air temperature and pressure, which vary between winter and summer.

Relative humidity usually varies from winter to summer. In Europe, relative humidity is higher in winter than in summer; in East Asia, this is reversed.

To illustrate this, the city of Brest, France, has all the climate characteristics that increase the seasonality of MI, whereas Seoul, South Korea, has none.

Hong Kong has some characteristics (temperature and humidity) that would increase the seasonality of heart attack incidence, and some that would reduce seasonality (air pressure).[8]

We assumed that Hong Kong does experience some seasonality in the incidence of heart attack, meaning that long-term exposure to cold increases the risk of heart attack and long-term exposure to heat reduces the risk of heart attack, relative to the annual average risk.

Heart attack incidence and PM2.5 air pollution

Short term

The meta-analysis by Mustafic et al. (2012) found a statistically significant association between PM2.5 and near-term increase in MI risk.

The meta-analysis by Farhadi et al. (2020) found a short-term association between PM2.5 and incidence of MI.

We assume an association between exposure to PM2.5 and incidence of heart attack over the short term.

We adopt the results of Farhadi et al. (2020) that a 10 μg/m^3 increase in PM2.5 is associated with a relative risk of 1.02.

Long term

Poulsen et al. (2023) found an association between five-year average PM2.5 concentrations and increased risk of MI.

Alexeeff et al. (2023) found an association between one-year average PM2.5 exposure and increased risk of MI.

We assume an association between exposure to PM2.5 and incidence of heart attack over the long term.

We assume a 10 μg/m^3 increase in PM2.5 associated with a relative risk of 1.09, which is roughly in line with the average result from Poulsen et al. (2023) and Alexeeff et al. (2023).

Heart attack incidence and ozone

Short term

The meta-analysis by Mustafic et al. (2012) found no association between ozone and incidence of MI.

Jiang et al. (2023) found an association between short-term average maximum eight-hour ozone concentrations and increased risk of hospitalization for MI.

Zhang et al. (2025) found an association between daily maximum eight-hour ozone concentration and increased risk of MI in young adults at 4-5 days after exposure.

We assume an association between exposure to ozone and incidence of heart attack over the short term.

We adopt the results of Jiang et al. (2023) because this is a significantly larger study. We assume that a 10 μg/m^3 increase in two-day average daily eight-hour maximum ozone concentration is associated with a 0.75% increase in admission risk.

Stroke incidence and temperature

Short term

Wen et al. (2023) noted previous studies suggested that ambient temperature was associated with stroke morbidity, although results among those investigations remained unclear. Their meta-analysis found that exposure to both extreme heat and extreme cold was associated with an increased risk of stroke over the short term.

Krasnov et al. (2025) found that mean, maximal, and minimal temperatures were associated with higher cumulative odds of ischemic stroke over lag 0-6 days.

We assume that exposure to extreme heat or extreme cold increases the incidence of stroke in the short term.

We adopt the results of Wen et al. (2023) and assume that short-term exposure to extreme heat increases the risk of stroke by 16%, and short-term exposure to extreme cold increases the risk of stroke (in developed countries) by 15%.

Stroke incidence and PM2.5 air pollution

Short term

The meta-analysis by Toubasi and Al-Sayegh (2023) found a significant association between PM2.5 exposure and the risk of ischemic stroke over the short term.

We adopt the results of Toubasi and Al-Sayegh (2023) and assume that a 10 μg/m^3 increase in PM2.5 concentration is associated with relative risk of 1.15.

Long term

The meta-analysis by Alexeeff et al. (2021) found a significant association between PM2.5 exposure and incidence of stroke over the long term.

This is supported by Hystad et al. (2020) in a large prospective cohort study.

We assume a 10 μg/m^3 increase in PM2.5 associated with a relative risk of 1.1, which is roughly in line with the average result from Hystad et al. (2020) and Alexeeff et al. (2023).

Stroke incidence and ozone

Short term

The meta-analysis by Toubasi and Al-Sayegh (2023) found a significant association between ozone exposure and the risk of ischemic stroke over the short term.

We adopt the results of Toubasi and Al-Sayegh (2023) that a 10 ppb (equivalent to approximately 20 μg/m^3) increase in ozone concentration is associated with relative risk of 1.05. We assume a 10 μg/m^3 increase in ozone concentration was associated with relative risk of 1.025.

Long term

Jin et al. (2022) found a statistically significant association between warm-season ozone levels and incidence of stroke. This is supported by Zhu et al. (2024).

Wright et al. (2023) found a statistically significant association between ozone levels and the risk of stroke.

We assume a 10 μg/m^3 increase in ozone concentration is associated with relative risk of 1.03, which is in line with the results of Wright et al. (2023). Zhu et al. (2024) and Jin et al. (2022) note higher and lower risks, respectively.

1 https://cd.epic.epd.gov.hk/EPICDI/air/station/?lang=en
2 https://www.ipcc.ch/report/ar6/wg2/chapter/chapter-10/
3 https://www.ipcc.ch/report/ar6/wg1/figures/chapter-6/figure-6-21
4 https://www.epd.gov.hk/epd/sites/default/files/epd/2023_Emission_Inventory_Report_Eng_final.pdf
5 https://cd.epic.epd.gov.hk/EPICDI/air/station/?lang=en
6 https://www.ipcc.ch/report/ar6/wg2/chapter/chapter-10/
7 https://www.ipcc.ch/report/ar6/wg1/figures/chapter-6/figure-6-20/
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Limitations

The information provided in this paper is intended for general discussion and education purposes only and should not be relied upon for making specific decisions. The potential change in annual incidence of critical illness claims in Hong Kong in 2050 is based on the assumptions specified, and different assumptions would give rise to different results.

RGA has made all reasonable efforts to ensure that the information provided in this publication is accurate at the time of inclusion and accepts no liability for any inaccuracies or omissions.