



## RESEARCH SUMMARY

# Mitigating the Air Pollution Effect? The Remarkable Decline in the Pollution- Mortality Relationship in Hong Kong

by Chun Wai Cheung, Guojun He, Yuhang Pan,  
*Journal of Environmental Economics and Management*

### KEY TAKEAWAYS

1. Hong Kong has among the highest per capita incomes in the world, but is also highly polluted. A significant portion of the pollution stems from the Pearl River Delta, a manufacturing hub northwest of Hong Kong.
2. Using air quality, weather, population, and mortality data, this study looks at the change in air pollution and cardio-respiratory deaths from 2000-2002—before a massive SARS epidemic in 2003—and compares it to the periods from 2004-2008 and 2009-2015.
3. The study finds that, on average, a 10-unit increase in the air pollution index (API) causes 1.77 percent more cardio-respiratory deaths each month, and the effect is larger among the elderly.
4. The effect of air pollution on cardio-respiratory deaths dramatically declined after 2003. From 2000-2002, increased air pollution led to a 3 percent increase in cardio-respiratory deaths. It had little to no impact during the more recent periods studied.
5. The researchers attribute the drop in cardio-respiratory deaths after the SARS epidemic to vast improvements in the medical system, and not to a drop in pollution itself or an increased awareness of pollution that could have led to a greater uptake of masks and air purifiers. Populations living closer to hospitals with emergency departments were less at risk of dying from pollution-induced cardio-respiratory diseases.

## Introduction

Hong Kong has among the highest per capita incomes in the world. But unlike other rich economies, Hong Kong is heavily polluted—with an average annual particulate pollution (PM10) concentration that is more than twice what the World Health Organization (WHO) considers to be safe.

A significant portion of Hong Kong's pollution comes from beyond its borders. Located near mainland China's Pearl River Delta Economic Zone—a manufacturing hub—the wind carries the pollution to Hong Kong, where almost no manufacturing exists. Particulate pollution from the Pearl River Delta accounts for more than half of the pollution in Hong Kong—and, sometimes as much as 70 percent of the pollution. Pollution is highest in the northwestern part of Hong Kong, which is closer to the Pearl River Delta.

**Figure 1** • Comparison of Annual Average Air Pollution Index in the PRDEZ and HK



## The SARS Epidemic

In 2003, nearly three hundred people in Hong Kong died of Severe Acute Respiratory Syndrome (SARS) brought on by the emergence of a coronavirus. During the SARS epidemic, daily life changed significantly. Most people avoided going outside during the outbreak, and those who did donned masks. Hospitals became overcrowded and lacked much of what was needed to keep people safe such as good ventilation, isolation facilities, and adequate intensive care facilities. The epidemic revealed basic failings of Hong Kong's healthcare system.

When the epidemic passed, Hong Kong overhauled its healthcare system: It added isolation beds, revamped intensive care units, adopted a series of infection control practices, launched massive staff training programs, built longer-term isolation facilities, and enhanced community-based services. In addition, it established the Centre for Health Protection to address public health issues and to help prevent communicable and non-communicable diseases. Since pneumonia is one of the leading causes of death in Hong Kong, measures were also adopted to reduce the transmission of respiratory diseases. These changes have significantly improved the availability of quality medical services in Hong Kong and are considered an important reason why the people of Hong Kong now live longer on average than any other population.

## Research Design

The connection between heavy air pollution and shorter lives is well documented. So, how is it that a heavily polluted city like Hong Kong could also have the world's highest life expectancy? The researchers sought to shed light on this question.

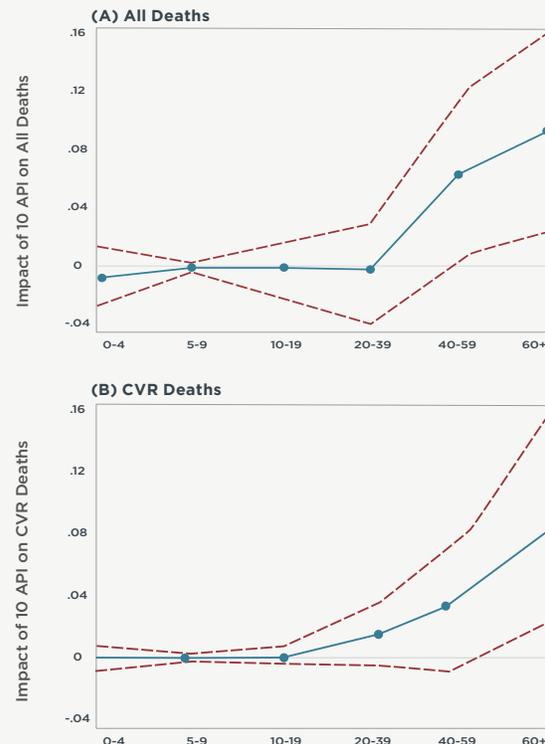
To estimate the causal impact of particulate pollution on mortality, they used 16 years of micro-level death data and combined it with population and air quality data from Hong Kong and the Pearl River Delta. They factored in distance and weather data such as wind direction and speed, temperature, and precipitation, to account for the source of the pollution.

The researchers studied the period from 2000-2015, splitting that time span into three segments: 2000-2002 (pre-SARS), 2004-2008 (immediately post-SARS), and 2009-2015. Because of the unusual economic, health and societal changes that occurred during the SARS outbreak in 2003 that could have impacted the results, that year was dropped from their analysis. This allowed them to compare pre- and post-SARS, as well as chronic changes in pollution over time.

## Findings

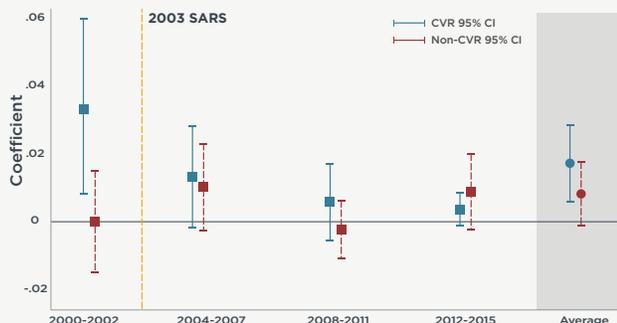
**1. Air pollution causes more people to die from cardio-respiratory diseases, with the elderly being most at risk.** Specifically, the study found that a 10-unit increase in the Air Pollution Index (API) can cause a 1.77 percent increase in monthly cardio-respiratory mortality, and the impact increases as people age. The analysis found that infants, children, and young adults do not die from short-term changes in air pollution in Hong Kong.

**Figure 2** • The Effect of API (per 10 units) on Deaths by Different Age Groups



**2. The effect of air pollution on mortality has dramatically declined in Hong Kong over the past two decades, having smaller impact on mortality after the 2003 SARS epidemic.** While there were no dramatic improvements in air quality in Hong Kong after the SARS epidemic, the amount of cardio-respiratory deaths linked to air pollution declined after 2003. From 2000-2002, a 10-unit increase in the API led to a 3 percent increase in cardio-respiratory deaths. As the chart shows, that same 10-unit increase in the API has had a diminishing effect on death rates since then and there is no apparent statistical significance on cardio-respiratory deaths after 2012.

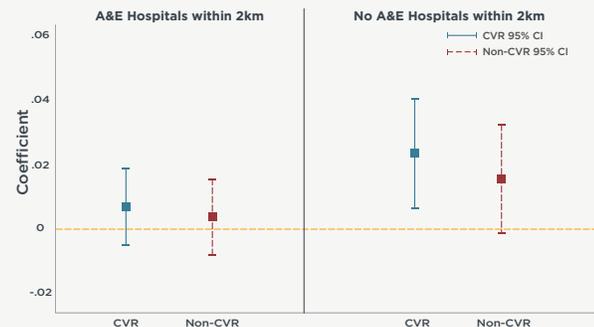
**Figure 3 • The Impact of Air Pollution Depends on the Accessibility of Emergency Services**



Note: The square dots represent the estimated impacts of a 10-point increase in the API on CVR mortality and non-CVR mortality using data from different periods. The vertical lines represent the corresponding 95% confidence intervals.

**3. People living closer to hospitals are less likely to die from air pollution.** A large number of medical studies have shown that air pollution often triggers acute cardiovascular diseases, such as strokes and heart attacks. When one's life is threatened by such acute diseases, immediate access to emergency care is critical. When comparing the impacts of air pollution on the number of cardio-respiratory deaths that occurred to people living close to hospitals versus those living further away, those living close to a hospital had a much smaller risk. This result, again, suggests that access to high-quality medical service can mitigate the health impact of air pollution.

**Figure 4 • The Impact of Air Pollution Depends on the Accessibility of Emergency Services**



Note: The square dots represent the estimated impacts of a 10-point increase in the API on CVR mortality and non-CVR mortality using data from different periods. The vertical lines represent the corresponding 95% confidence intervals.

**4. The analysis tries to rule out other causes for the drop in cardio-respiratory deaths linked to air pollution after SARS, such as a non-linear dose-response, a decrease in smoking or an increase in avoidance behaviors.** The researchers find that the dose-response relationship between API and cardio-respiratory mortality is approximately linear, so the drop is unlikely to be caused by improvement in air quality. The researchers also test whether people became more aware of the dangers of air pollution after 2003, leading them to buy more masks and air purifiers to shield them from pollution. They found, however, that people in Hong Kong did not change their response to air pollution over time—unlike in mainland China, where people search for masks and air purifiers when the API is registering high. Further, smoking patterns remained almost unchanged during the entire period studied.

“There are many tools governments should use to reduce pollution and the impacts of that pollution on citizens’ health. Improving healthcare systems is another tool to add to the arsenal, and one that can deliver far-reaching benefits.”

**GUOJUN HE, DIRECTOR OF RESEARCH, EPIC-CHINA; ASSISTANT PROFESSOR, HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY.**

## Policy Recommendations

This study provides the first evidence that better medical institutions and high-quality healthcare can mitigate the impact of air pollution. As such, Hong Kong offers a future scenario for growing cities in the developing world that are seeing rising air pollution alongside rising incomes. Even in places like Hong Kong, where local governments do not have jurisdiction over the most important sources of local pollution, they can still take steps to mitigate its effects on their people.

Further, supplementing pollution reduction policies with improvements in the healthcare system offers far-reaching benefits beyond those associated with air pollution. For example, Hong Kong has a similar population to New York City, and receives 50 times more travelers from mainland China each year. But as of May 1, 2020, Hong Kong had about 1,040 cases of COVID-19 and 4 deaths. New York City had 169,690 cases and about 18,400 deaths.

Hong Kong learned from its experience with SARS and made improvements that helped the city decrease the impact of air pollution, be more prepared for future viruses, and likely foster a host of other health advances for its people. Like SARS in Hong Kong, COVID-19 is exposing weaknesses in healthcare systems worldwide. It remains to be seen whether other countries and cities will recognize and learn from these failings, and make improvements that could reduce the impact of air pollution in pollution hotspots today.

The Energy Policy Institute at the University of Chicago (EPIC) is confronting the global energy challenge by working to ensure that energy markets provide access to reliable, affordable energy, while limiting environmental and social damages. We do this using a unique interdisciplinary approach that translates robust, data-driven research into real-world impacts through strategic outreach and training for the next generation of global energy leaders.