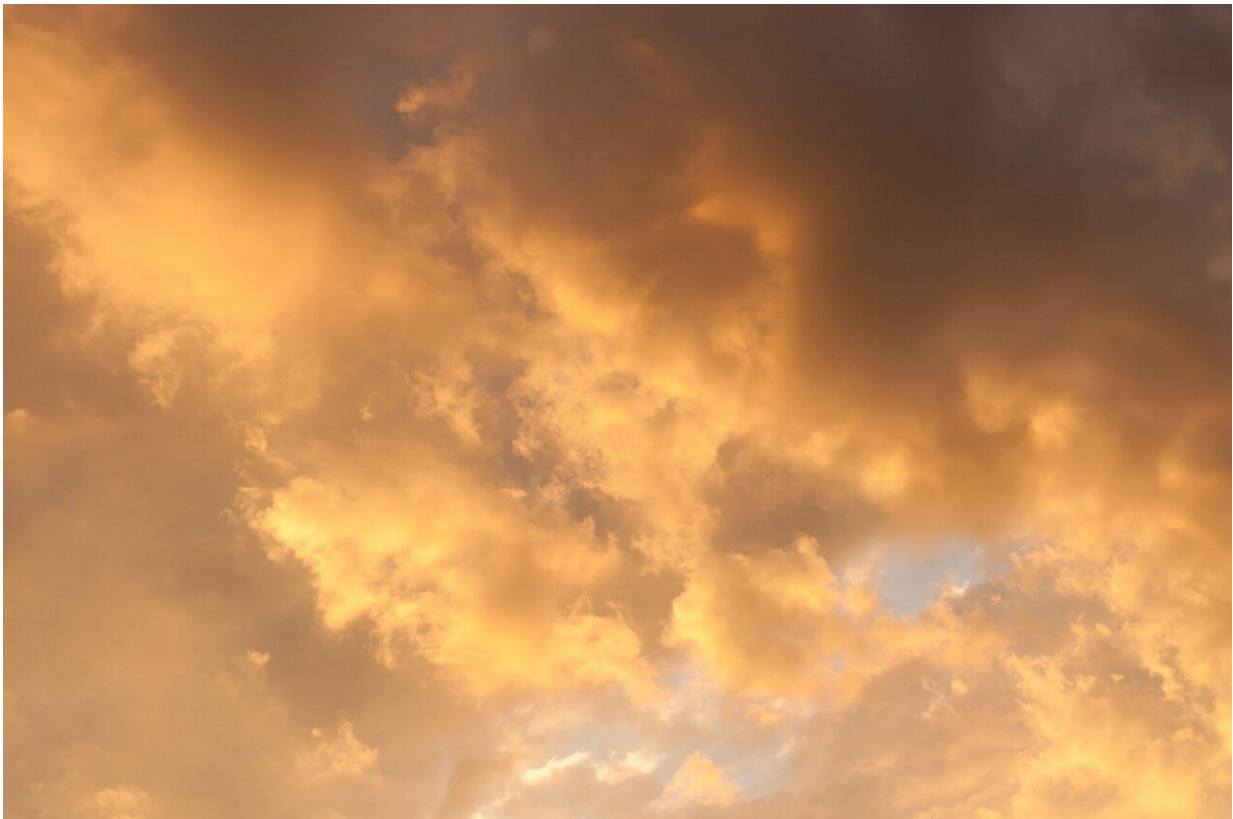


# Ozone pollution is linked with increased hospitalizations for cardiovascular disease

March 9 2023

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The first evidence that exceeding the World Health Organization (WHO) ozone limit is associated with substantial increases in hospital admissions for heart attack, heart failure and stroke is published today in *European*

*Heart Journal*. Even ozone levels below the WHO maximum were linked with worsened health.

"During this three-year study, ozone was responsible for an increasing proportion of admissions for cardiovascular disease as time progressed," said study author Professor Shaowei Wu of Xi'an Jiaotong University, China.

"It is believed that climate change, by creating atmospheric conditions favoring ozone formation, will continue to raise concentrations in many parts of the world. Our results indicate that older people are particularly vulnerable to the adverse cardiovascular effects of ozone, meaning that worsening [ozone pollution](#) with climate change and the rapid aging of the global population may produce even greater risks of cardiovascular disease in the future."

Ozone is a gas and the main air pollutant in photochemical smog. Ozone pollution is different to the [ozone layer](#), which absorbs most of the sun's ultraviolet radiation. Ozone pollution is formed when other pollutants react in the presence of sunlight. These other pollutants are [volatile organic compounds](#) and [nitrogen oxides](#) which are emitted by motor vehicles, power plants, industrial boilers, refineries, chemical plants, and biomass and fossil fuel burning facilities. Previous studies have suggested that ozone pollution harms the heart and blood vessels, but there is limited and inconclusive evidence about its influence on the risk of cardiovascular disease.

This study examined the association between ambient ozone pollution and hospital admissions for cardiovascular disease. Data on daily hospital admissions for cardiovascular disease during 2015 to 2017 in 70 cities in China were collected from the two main national health insurance systems.

During the study period, the two databases covered approximately 258 million people across the 70 cities, equivalent to more than 18% of China's population. The types of cardiovascular disease included [coronary heart disease](#), stroke and heart failure, plus subtypes such as angina, acute myocardial infarction, acute coronary syndrome, ischemic stroke and hemorrhagic stroke.

Daily eight-hour maximum average concentrations of ozone, [fine particulate matter](#) (PM2.5), inhalable particles (PM10), [sulfur dioxide](#), nitrogen dioxide and carbon monoxide were obtained for each city from the China National Urban Air Quality Real-time Publishing Platform.

During the study period, there were 6,444,441 hospital admissions for cardiovascular disease in the 70 cities and the average daily eight-hour maximum ozone concentration was  $79.2 \mu\text{g}/\text{m}^3$ . Exposure to ambient ozone was associated with increased hospital admissions for all cardiovascular diseases studied except hemorrhagic stroke, independent of other air pollutants. [For example, each](#)  $10 \mu\text{g}/\text{m}^3$  rise in the two-day average eight-hour maximum ozone concentration was associated with a 0.40% increase in hospital admissions for stroke and 0.75% for acute myocardial infarction.

Professor Wu said, "Although these increments look modest, it should be noted that ozone levels may surge to higher than  $200 \mu\text{g}/\text{m}^3$  in summer, and these increases in hospitalizations would be amplified by more than 20 times to over 8% for stroke and 15% for acute myocardial infarction."

The researchers also estimated the excessive admission risk for cardiovascular disease associated with ozone concentrations at or above the WHO air quality guideline ( $100 \mu\text{g}/\text{m}^3$ ) compared to levels below  $70 \mu\text{g}/\text{m}^3$ . Ozone levels below  $70 \mu\text{g}/\text{m}^3$  are mostly naturally occurring and not due to human activity.

Compared to two-day average eight-hour maximum concentrations below  $70 \mu\text{g}/\text{m}^3$ , levels of  $100 \mu\text{g}/\text{m}^3$  or higher were associated with substantial increases in hospital admissions for cardiovascular disease, ranging from 3.38% for stroke to 6.52% for acute myocardial infarction. Nevertheless, lower concentrations of 70 to  $99 \mu\text{g}/\text{m}^3$  (vs. below  $70 \mu\text{g}/\text{m}^3$ ) were also linked with increases in hospital admissions, ranging from 2.26% for heart failure to 3.21% for coronary heart disease.

During 2015 to 2017, 3.42%, 3.74% and 3.02% of hospitalizations for coronary heart disease, [heart failure](#) and stroke, respectively, were attributable to ozone pollution. When each year was analyzed separately, the proportions rose with time. For coronary heart disease, ozone was responsible for 109,400 of 3,194,577 admissions over three years.

Professor Wu said, "This suggests that 109,400 coronary heart disease admissions could have been avoided if ozone concentrations were  $0 \mu\text{g}/\text{m}^3$ . This may be impossible to achieve given the presence of ozone from natural sources. However, we can conclude that considerable numbers of [hospital admissions](#) for [cardiovascular disease](#) could be avoided if levels were below  $100 \mu\text{g}/\text{m}^3$ , with further reductions at lower concentrations."

In an accompanying editorial, Professor Thomas Münzel and co-authors said, "Projections for Europe suggest that ozone will play a more dominant role as a health risk factor in the future due to climate change with rising temperature and, accordingly, increasing photochemical formation of ozone. The strong link between [climate change](#) and air quality means that reducing emissions in the long term to tackle global warming will play a key role in alleviating [ozone](#) pollution and improving the air that we breathe."

**More information:** Shaowei Wu et al, Ozone Pollution and Hospital Admissions for Cardiovascular Events, *European Heart Journal* (2023).

[DOI: 10.1093/eurheartj/ehad091](https://doi.org/10.1093/eurheartj/ehad091)

Provided by European Society of Cardiology

Citation: Ozone pollution is linked with increased hospitalizations for cardiovascular disease (2023, March 9) retrieved 11 March 2023 from <https://medicalxpress.com/news/2023-03-ozone-pollution-linked-hospitalizations-cardiovascular.html>

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