

NEWS RELEASE

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NTU Singapore-led study links increasing air pollution to the rise of a type of lung cancer

Findings also reveal decline in smoking led to decrease in another type of lung cancer

An international team of scientists, led by **Nanyang Technological University, Singapore (NTU Singapore)**, has linked increased air pollution to an uptick in cases of **lung adenocarcinoma (LADC)** worldwide. The same study also concluded an overall lower consumption of tobacco worldwide is statistically linked to less people contracting **lung squamous cell carcinoma (LSCC)**.

Lung adenocarcinoma is a type of cancer for which research strongly suggests that genetic, environmental, and lifestyle factors play a part, while lung squamous cell carcinoma is often linked to a history of smoking.

This study, done in collaboration between NTU and the Chinese University of Hong Kong, showed that a 0.1 micrograms per cubic metre ($\mu\text{g}/\text{m}^3$) increment of black carbon¹, also known as soot, in the Earth's atmosphere, is associated with a 12 per cent increase in LADC incidence globally.

Black carbon is a pollutant that is classified as under PM_{2.5}², and the research team found that it has increased globally by 3.6 $\mu\text{g}/\text{m}^3$ yearly from 1990 to 2012.

Meanwhile, a one per cent decline of smoking prevalence was associated with a nine per cent drop in LSCC incidence globally. The number of smokers worldwide decreased by 0.26 per cent a year, cumulatively falling by nearly six per cent from 1990 to 2012.

Lung cancer remains the leading cause of cancer with an estimated 1.8 million deaths in 2020, according to CA: A Cancer Journal for Clinicians³. Global statistics have

¹ Black carbon is the sooty black material emitted from gas and diesel engines, coal-fired power plants, and other sources that burn fossil fuel.

² Atmospheric particulate matter (PM) that has a diameter of less than 2.5 micrometers - about three-hundredths the diameter of a human hair.

³ CA: A Cancer Journal for Clinicians. Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries (2020).

highlighted the trends of lung cancers, but understanding what may be causing them has been unclear, until the NTU-led study, which has associated the incidence of the cancers to tobacco consumption and air pollution.

Professor Joseph Sung, NTU's Senior Vice President (Health and Life Sciences) and Dean, Lee Kong Chian School of Medicine (LKC Medicine), who led the study, said: "In our study, we were able to determine that the global increase of lung adenocarcinoma is likely associated with air pollution. It had always been unclear, in the past decades, why we are seeing more females and more non-smokers developing lung cancer worldwide. Our study points to the importance of environmental factors in the causation of specific types of lung cancer."

Associate Professor Steve Yim, from NTU's Asian School of the Environment, who holds an appointment at LKC Medicine, the first author of the study, said: "Our study provided us with an indication as to the reason behind the rising trend of lung adenocarcinoma, despite the decreasing trend of smoking prevalence. Our findings pinpoint the necessity and urgency to reduce air pollutant emissions especially black carbon."

The study analysed data from the World Health Organisation from 1990 to 2012 for data on lung cancers, while the dataset for age-standardised smoking prevalence rates from 1980 to 2012 was derived from the Institute for Health Metrics and Evaluation, an independent global health research centre at the University of Washington. The statistics on pollution were obtained from National Aeronautics and Space Administration (NASA). Pollutants that were analysed were black carbon, sulfate⁴, and PM_{2.5}.

The results of the study were published in the peer-reviewed academic journal *Atmospheric Environment* in November.

Gender and geography have a role to play

The links between lung cancers and black carbon also vary between different genders across different continents. For instance, the link between the pollutant and the incidence of both LADC and LSCC was stronger in females than in males.

Globally, a 0.1 µg/m³ annual increment of black carbon was linked to a 14 per cent rise in LADC in women, compared to nine per cent in men. As for LSCC, the same

⁴ Sulfates come from the combustion of petroleum-derived that contain sulfur. Inhaling them can cause reduced lung function, aggravated asthmatic symptoms, and increased risk of emergency department visits, hospitalisations, and death in people who have chronic heart or lung diseases.

increase in the pollutant was linked to a 14 per cent increase in females, compared to eight per cent in the opposite sex.

The study found that the link between air pollutants and LADC varied across continents. In North America, a 0.1 $\mu\text{g}/\text{m}^3$ increment of black carbon was linked to a ten per cent increase in LADC cases, compared to seven per cent in Europe.

In the study, global data demonstrates that the drop in LSCC is more significant among males, said the researchers, and that the declining trend coincides with the declining trend of tobacco consumption.

However, despite the overall decreasing trend of tobacco usage, a positive association between smoking and LSCC was demonstrated for females in Asia, North America and Oceania, where a one per cent increment in the number of female smokers was associated with a 12 per cent increase of the cancer in those geographies.

Impact of population growth and rising air pollution

The scientists explained that despite lower overall percentage of smokers worldwide, there were more smokers worldwide due to massive population growth from 1980 to 2012, resulting in the number of female smokers increasing seven per cent.

The rising incidence of LADC is particularly prominent in Asia, where emissions of black carbon and sulfate have been on the rise, according to the scientists.

LADC among males in Asia saw the largest increasing trend, increasing by 24 per cent yearly, mainly contributed by the prominent rises in Japan (38 per cent yearly) and South Korea (37 per cent yearly). For females in Asia, LADC increased by 25 per cent year, similarly, with both Japan (43 per cent yearly) and South Korea (36 per cent yearly) showing a clear increasing trend.

The researchers highlight the prominent trend of air pollution in Asia, in which black carbon (11.9 $\mu\text{g}/\text{m}^3/\text{year}$) and sulfate (35.4 $\mu\text{g}/\text{m}^3/\text{year}$) showed the highest increase worldwide, with South Korea presenting the largest increase for both pollutants.

The combustion of fossil fuel for power generation or transportation has long been known as the source of particulate air pollution in most urban settings. It also worsens climate change by increasing the carbon dioxide emissions, which cause global warming.

Prof Sung added: "Results of this study should give us fair warning that air pollution should be better controlled to protect health and avoid premature deaths from lung cancer or related illnesses, particularly in populations that live near urban areas, which

are known to experience high levels of pollutant emissions. Air pollution, together with climate change, is one of the greatest environmental threats to human health. Our findings underscore the urgent need for further research into how pollutants such as black carbon and sulfate lead to the development of lung adenocarcinoma, and for international leaders and experts to look into mitigation strategies for air pollution.”

Assoc Prof Yim added: “While national environmental regulatory bodies commonly measure and report on the levels of fine particulate matter, our results pinpoint the importance to measure individual types of particulates, especially, black carbon. The information would be useful for formulating effective emission control policies, supporting policies for sustainable development.”

The team plans to carry out further research to investigate the functions of black carbon and sulfate in the development of LADC, which could lead to new studies to combat the surge of the cancer. The team also hopes to explore other pollutants that might be linked to lung cancers.

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Note to Editors:

The NTU research paper titled “[Rise and fall of lung cancers in relation to tobacco smoking and air pollution: A global trend analysis from 1990 to 2012](#)” is published in *Environmental Research*, 9 Nov 2021. DOI 10.1016/j.atmosenv.2021.118835

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About Nanyang Technological University, Singapore

A research-intensive public university, Nanyang Technological University, Singapore (NTU Singapore) has 33,000 undergraduate and postgraduate students in the Engineering, Business, Science, Humanities, Arts, & Social Sciences, and Graduate colleges. It also has a medical school, the Lee Kong Chian School of Medicine, established jointly with Imperial College London.

NTU is also home to world-renowned autonomous institutes – the National Institute of Education, S Rajaratnam School of International Studies, Earth Observatory of Singapore, and Singapore Centre for Environmental Life Sciences Engineering – and various leading research centres such as the Nanyang Environment & Water Research Institute (NEWRI) and Energy Research Institute @ NTU (ERI@N).

Ranked amongst the world's top universities by QS, NTU has also been named the world's top young university for the last seven years. The University's main campus is frequently listed among the Top 15 most beautiful university campuses in the world and it has 57 Green Mark-certified (equivalent to LEED-certified) building projects, of which 95% are certified Green Mark Platinum. Apart from its main campus, NTU also has a campus in Singapore's healthcare district.

Under the NTU Smart Campus vision, the University harnesses the power of digital technology and tech-enabled solutions to support better learning and living experiences, the discovery of new knowledge, and the sustainability of resources.

For more information, visit www.ntu.edu.sg