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Ship engine emissions adversely affect macrophages

HELMHOLTZ ZENTRUM MÜNCHEN - GERMAN RESEARCH CENTER FOR ENVIRONMENTAL HEALTH



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In cooperation with colleagues of the University of Rostock, the University of Luxembourg, the Max Delbrueck Center for Molecular Medicine, the Karlsruhe Institute of Technology and the University of Eastern Finland, the Munich Scientists have now published the results in the journal *PLOS ONE*. In 2015 they already showed that exposure to particle emissions from heavy fuel oil (HFO) and diesel fuel (DF) adversely affects human lung cells and is responsible for strong biological responses of the cells ("How Ship Emissions Adversely Affect Lung Cells"). For example, inflammatory processes are triggered that may influence the development of interstitial lung diseases. Now the team led by Professor Ralf Zimmermann has found in further studies that macrophages are also influenced by the exhaust gases. These are much more sensitive than lung epithelial cells and therefore react more strongly to exposure. Zimmermann is speaker of the international consortium Helmholtz Virtual Institute of Complex Molecular Systems in Environmental Health (HICE), head of the cooperation group Comprehensive Molecular Analytics (CMA) at Helmholtz Zentrum Muenchen and head of the Department of Analytical Chemistry at the University of Rostock.

"Macrophages are known as scavenger cells of the immune system and respond more sensitively to particulate matter in the lungs than lung epithelial cells, since they are the 'first line of response' against foreign invaders in the lungs such as germs or even fine dust particles," said Sean Sapcarui, first author of the study and doctoral student at the University of Luxembourg, a cooperation partner in HICE. "We found that the ship emissions of heavy fuel oil and diesel fuel had different effects on triggering pro-inflammatory reactions," said Sapcarui. Fine particles from heavy fuel oil emissions have a stronger effect on the development of pro-inflammatory reactions than particles emitted from diesel ship engines, but the latter more strongly influence other fundamental biological processes such as DNA-, RNA- and protein-synthesis.

"We then found that the emitted particles both from the heavy fuel oil and from the diesel exhaust had similarly high toxic effects on the macrophages. Surprisingly, the toxic effects leading to cell death are even slightly lower in the heavy fuel oil emissions, although the concentrations of known toxic pollutants in the heavy oil emissions are much higher," Zimmermann added. "Foregoing the ban of the heavy fuel oil use in coastal shipping, as is currently propagated and partially already implemented via the current fuel-sulfur content regulations, is therefore probably less beneficial than expected for protecting the health of people in coastal areas. The simplest and safest way to mitigate these adverse health effects from ship engine emissions would be to introduce efficient particle reducing measures such as exhaust gas scrubbers and particle filters. These would precipitate the harmful fine particles from the emissions and thus reduce the adverse health effects, irrespective of the fuel used. Since such measures are generally not implemented on a voluntary basis, in our view there is an urgent need for action by policy makers in government and by national and European regulatory authorities".

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Further Information

Background: Macrophages are white blood cells and are part of the immune system. They are often referred to as scavenger cells, because they absorb and engulf microorganisms. In addition, the cells destroy tumor cells, remove cell debris, present antigens and promote wound healing.

Publication: Sapcarui, S. C.et al. (2016). Metabolic Profiling as well as Stable Isotope Assisted Metabolic and Proteomic Analysis of RAW 264.7 Macrophages Exposed to Ship Engine Aerosol Emissions: Different Effects of Heavy Fuel Oil and Refined Diesel Fuel, *PLOS ONE*, Volume 10, DOI: 10.1371/journal.pone.0157964

Link to publication: <http://journals.plos.org/plosone/article?id=10.1371%2Fjournal.pone.0157964>

As German Research Center for Environmental Health Helmholtz Zentrum Muenchen pursues the goal of developing personalized medical approaches for the diagnosis, prevention and treatment of major common diseases such as diabetes mellitus and lung diseases. To achieve this, it investigates the interaction of genetics, environmental factors and lifestyle. The head office of the center is located in Neuherberg to the north of Munich. Helmholtz Zentrum München has approximately 2300 staff members and is a member of the Helmholtz Association, a German research organization comprised of 18 scientific-technical and medical-biological research centers with around 37,000 employees. <https://www.helmholtz-muenchen.de/en/index.html>

The independant Cooperations group Comprehensive Molecular Analytics (CMA) is a research collaboration between Helmholtz Zentrum Muenchen and the University of Rostock (Department of Analytical Chemistry). The research activities focus on the development and application of mass spectrometric analysis techniques to characterize complex molecular compounds. In the Joint Mass Spectrometry Center (JMSC) new measurement technologies are being developed and molecular profiles created, particularly with regard to the analysis of aerosols and their effects on health.

The University Luxemburg founded in 2003, is the only public university of the Grand Duchy of Luxembourg. It sees itself as a multilingual, international and research-oriented university with a personal atmosphere. The University of Luxembourg has declared international cooperation to be one of its top priorities, in order to achieve excellence in research and teaching.

The Max-Delbrueck-Centrum fuer Molekulare Medizin (MDC) in the Helmholtz Association carries out basic biomedical research with the aim of understanding the molecular basis of health and disease, and translating these findings as quickly as possible into clinical application. The research involves the diagnosis and treatment of diseases, as well as their prevention.

The Karlsruher Institute of Technology (KIT) was established on October 1, 2009 in conjunction with the official merger of Forschungszentrum Karlsruhe and the University of Karlsruhe. KIT combines the functions of a university of the State of Baden-Wuerttemberg and a research institution of the Helmholtz Association in research, teaching and innovation. It is the research university in the Helmholtz Association.

The University of Rostock ranks among the ten most start-up-friendly universities in Germany. The economy of the Rostock region benefits from the 800 spin-offs of the university since 1991. The character of the city is strongly influenced by the 5,000 employees of the university and the university hospital and the 15,000 students.

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