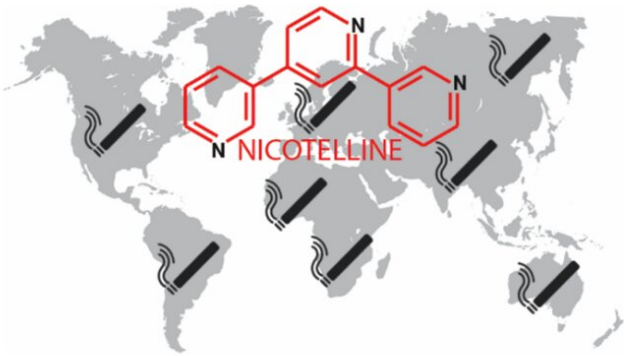
Study shows airborne particulate matter is also contaminated with tobacco smoke-driven particulates

February 12 2021



Credit: University of Malta

In a courtesy call to HE the President of Malta at San Anton Palace on Thursday, February 11, 2021, Dr. Noel Aquilina from the Department of Chemistry, accompanied by Professor Emmanuel Sinagra, Head of the Department of Chemistry and Dean of the Faculty of Science at the University of Malta, presented the findings of a landmark study. This study shows and confirms that airborne particulate matter (PM), apart from several toxic components, is also contaminated with tobacco smoke-driven particulates.

After 30 years, Dr. Noel Aquilina, alongside world renowned tobacco smoke-related researchers, Emeritus Professor Neal L. Benowitz and Dr. Peyton Jacob III from the University of California San Francisco (UCSF), USA and atmospheric chemist and Fellow of the Royal Society, Professor Roy M. Harrison, from the University of Birmingham, UK, ended the wait for the elusive marker.

This remarkable study was published in one of the most prestigious journals of air quality, *Environment International* and was supported by the California Tobacco-Related Disease Research Program, the National Institute on Drug Abuse, the National Center for Research Resources and the UCSF Bland Lane Center of Excellence on Secondhand Smoke.

About 6 trillion cigarettes were smoked worldwide in 2016. Considering a conservative value, worldwide, secondhand smoke (SHS) (from cigarette smoking alone), releases about 22 million kilograms of nicotine and about 135 million kilograms of PM into the atmosphere each year. What is the fate of those particles?

The criteria for an ideal marker are that this is expected to behave similarly to the material for which it is a marker (in this case, cigarette SHS PM) under a range of environmental conditions and can be detected at low concentrations. For this purpose, historically, several studies tried to find a marker to show exposure to ambient SHS. Since 1991, the main marker of choice was Nicotine. Later studies have verified that nicotine is found almost exclusively in the gas-phase and would underestimate the exposure to the particle-phase of SHS; ages differently from other substances thus explaining the poor correlation with other SHS components; it has high adsorption rate to surfaces and easily desorbs from surfaces in the absence of active smoking. This meant that Nicotine was neither adequate nor suitable as a marker to SHS in PM. Over the last 3 decades, 16 different markers were tried and tested but all failed in one way or another to satisfy the necessary marker

characteristics.

In 2013, at the Division of Cardiology, Clinical Pharmacology Program, Department of Medicine, UCSF, Nicotelline, a tripyridine alkaloid found in tobacco leaves and tobacco smoke, having a low volatility, led to hypothesize that it would be found mainly in the PM of SHS and should therefore be a useful tracer for tobacco smoke PM. It was thought that Nicotelline would be expected to be more stable in the environment than previously tested tracers for SHS. The 2013 study led by Dr. Jacob III, was limited to a chamber, highly controlled environment, dealing with very few short-time airborne samples and deposited dust samples. Those findings were not sufficient to verify the requested marker characteristics.

In 2016, Dr. Aquilina, one of the few European Affiliate Researchers of the Thirdhand Smoke (THS) Research Consortium, was invited by UCSF to:

- Coordinate a comprehensive air sampling campaign in several countries with different climates, to show the ubiquitous presence of Nicotelline in airborne samples. Samples were collected in six cities in California including San Francisco; USA, Birmingham; UK, three sites in Hong Kong; PR China and Msida; Malta;
- Develop an analytical method to extract Nicotine, Nicotelline and other tobacco-related compounds from airborne sample;
- Validate the extraction method against a standard reference material and show that Nicotelline can be detected reliably at very low concentrations;
- Carry out tests to verify the atmospheric stability of Nicotelline in relation to Nicotine in PM.

The samples for the test to show the most important and necessary

property for a marker, atmospheric stability, and hence confirm its suitability as a marker, have been collected on the University of Malta, Msida campus in 2018 using the Mobile Air Quality Laboratory equipment operated by the Faculty of Science. A suite of real-time monitors were used in conjunction with localised meteorological data to verify the atmospheric conditions which could influence the stability of Nicotelline on filters during sampling.

The study has shown that:

- Nicotelline can be considered as a suitable marker for tobacco-smoke driven particulate matter in SHS;
- The marker shows a ubiquitous presence even at low concentrations and geographical variability linked to population density and tobacco use prevalence;
- The mean load of tobacco smoke particulate in airborne particulate matter is 0.06 %.
- In 2010, about 1 % of the global mortality was attributed to SHS exposure. Lower respiratory infections in children younger than 5 years, ischaemic heart disease in adults, and asthma in adults and children indicate there is no risk-free level of exposure to SHS.

Given the abovementioned health implications, what does this study add to the scientific community?

Although airborne PM is generally loaded with several pollutants that can be mutagenic, genotoxic and carcinogenic due to different sources, now it is confirmed that a small load of PM comes exclusively from tobacco smoke, hence air is also contaminated with tobacco smoke.

Although the load appears to be too low to be of an immediate hazard, this marker has set a new standard on the possible chronic exposure to

SHS/THS through inhalation of PM even in non-smoking environments.

The importance and significance of this study is that it has opened a gateway to research the potent tobacco-specific carcinogens present in PM, and their health implications in inducing lung cancer, but not only, associated with a continuous exposure. These are THS components which are the frontier of science associated with tobacco smoke and its health effects. There is the need to look into additional exposure pathways, including dermal uptake, hand-to-mouth transfer and by inhalation of secondary particles that form after re-emission from surfaces. This is where a suitable particle-phase marker will be used, to distinguish the contribution of past indoor smoking from what is an unavoidable contamination originating outdoors.

More information: Noel J. Aquilina et al, Ubiquitous atmospheric contamination by tobacco smoke: Nicotine and a new marker for tobacco smoke-derived particulate matter, nicotelline, *Environment International* (2021). DOI: 10.1016/j.envint.2021.106417

Provided by University of Malta