

Third-hand smoke shown to cause health problems

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Smoking harms nearly every organ in the body and causes many diseases. Credit: CDC/Debora Cartagena

Do not smoke and do not allow yourself to be exposed to smoke because second-hand smoke and third-hand smoke are just as deadly as first-hand smoke, says a scientist at the University of California, Riverside who, along with colleagues, conducted the first animal study of the effects of third-hand smoke.

While first-hand smoke refers to the smoke inhaled by a smoker and second-hand smoke to the exhaled smoke and other substances emanating from the burning cigarette that can get inhaled by others, third-hand smoke is the second-hand smoke that gets left on the surfaces of objects, ages over time and becomes progressively more toxic.

"We studied, on mice, the effects of third-hand smoke on several organ systems under conditions that simulated third-hand smoke exposure of humans," said Manuela Martins-Green, a professor of cell biology who led the study. "We found significant damage occurs in the liver and lung. Wounds in these mice took longer to heal. Further, these mice displayed hyperactivity."

[Study results](#) appear in *PLOS ONE*.

The results of the study provide a basis for studies on the toxic effects of third-hand smoke in humans and serve to inform potential regulatory policies aimed at preventing involuntary exposure to third-hand smoke.

Third-hand smoke is a potential health threat to children, spouses of smokers and workers in environments where smoking is, or has been, allowed. Contamination of the homes of smokers by third-hand smoke is high, both on surfaces and in dust, including children's bedrooms. Re-emission of nicotine from contaminated indoor surfaces in these households can lead to nicotine exposure levels similar to that of smoking. Third-hand smoke, which contains strong carcinogens, has been found to persist in houses, apartments and hotel rooms after smokers move out.

The team led by Martins-Green found that the mice exposed to third-hand smoke in the lab showed alterations in multiple [organ systems](#) and excreted levels of a tobacco-specific carcinogen similar to those found in children exposed to second-hand smoke (and consequently to third-hand

smoke):

- In the liver, third-hand smoke was found to increase lipid levels and non-alcoholic [fatty liver disease](#), a precursor to cirrhosis and cancer and a potential contributor to cardiovascular disease.
- In the lungs, third-hand smoke was found to stimulate excess collagen production and high levels of inflammatory cytokines (small proteins involved in cell signaling), suggesting propensity for fibrosis with implications for inflammation-induced diseases such as chronic obstructive pulmonary disease and asthma.
- In wounded skin, healing in mice exposed to third-hand smoke showed many characteristics of the kind of poor healing observed in human smokers who have gone through surgery.
- Finally, in behavioral tests the mice exposed to third-hand smoke showed hyperactivity.

"The latter data, combined with emerging associated behavioral problems in children exposed to second- and third-hand smoke suggests that with prolonged exposure, they may be at significant risk for developing more severe neurological disorders," Martins-Green said.

Although the potential risks attributed to third-hand smoke exposure are increasing, virtually nothing was known about the specific health implications of acute or cumulative exposure—until now.

"There is a critical need for animal experiments to evaluate biological effects of exposure to third-hand smoke that will inform subsequent human epidemiological and clinical trials," Martins-Green said. "Such studies can determine potential human health risks, design of clinical trials and potentially can contribute to policies that lead to reduction in

both exposure and disease."

Her research team was surprised to find that the damage caused by third-hand smoke extends to several organs in the body.

"More recently we have found that exposure to third-hand smoke results in changes that can lead to type II diabetes even when the person is not obese," Martins-Green said. "There is still much to learn about the specific mechanisms by which cigarette smoke residues harm nonsmokers, but that there is such an effect is now clear. Children in environments where smoking is, or has been allowed, are at significant risk for suffering from multiple short-term and longer health problems, many of which may not manifest fully until later in life."

Research has shown that children living with one or two adults who smoke in the home, where second- and third-hand smoke are abundant, are absent 40 percent more days from school due to illness than children who did not live with smokers.

The first complete ban in the world on indoor [smoking](#) in all public spaces—including bars and restaurants—occurred in 1990 in San Luis Obispo, Calif. Earlier this month, UC Riverside joined the rest of the University of California campuses and facilities by going smoke- and tobacco-free. No tobacco use of any kind is allowed on campus property, a policy that extends to electronic cigarettes also.

Martins-Green was joined in the research by Neema Adhami, Michael Frankos, Mathew Valdez, Benjamin Goodwin, Julia Lyubovitsy, Sandeep Dhall, Monika Garcia, Ivie Egiebor, Bethanne Martinez, Harry W. Green and Margarita Curras-Collazo at UCR; Christopher Havel, Lisa Yu, Neal Benowitz, and Peyton Jacob III at UC San Francisco; Sandy Liles, Melbourne Hovell and Georg Matt at San Diego State University; Hugo Destailats, Mohammed Sleiman and Laura A. Gundel

at Lawrence Berkeley National Laboratory, Calif.; and Jonathan P. Winickoff at Harvard Medical School, Mass.

Martins-Green's lab collaborated with Curras-Collazo's lab to evaluate the effects on mice of third-hand smoke.

Provided by University of California - Riverside

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