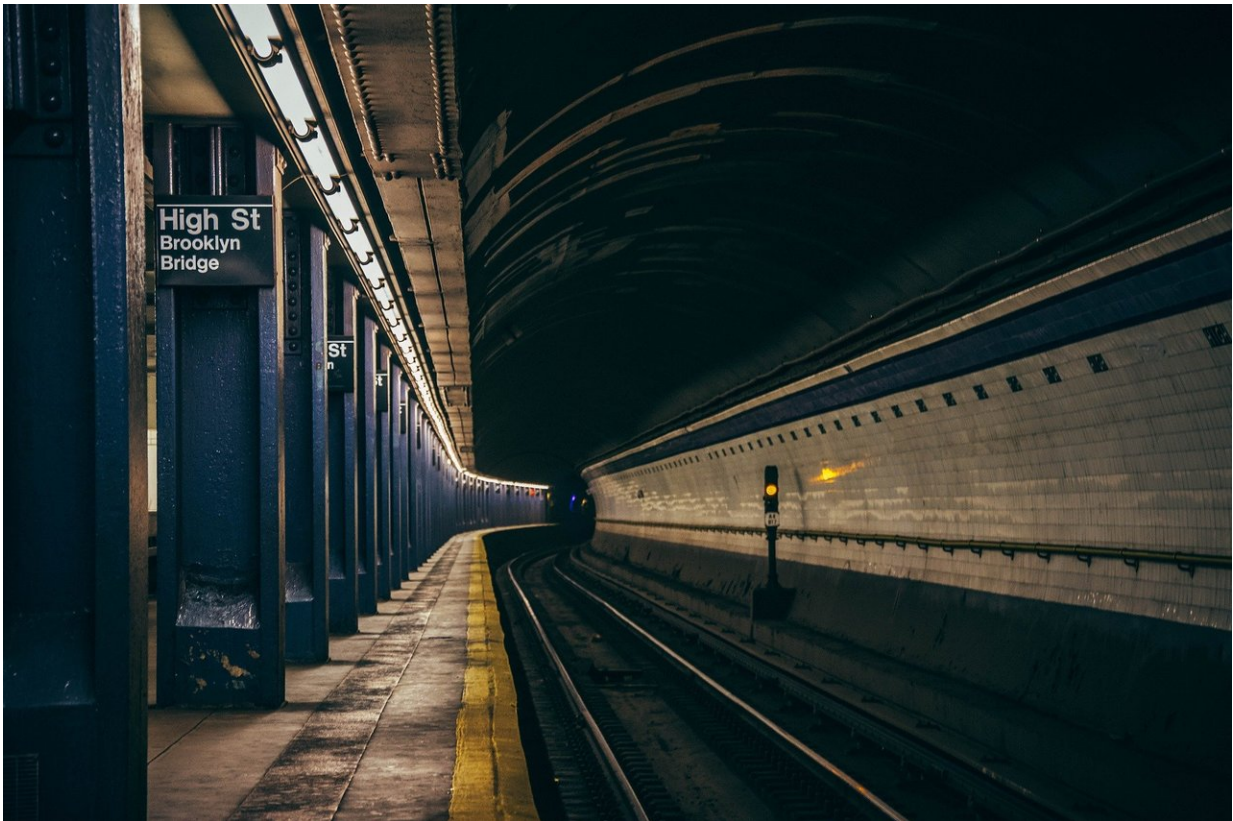


Is underground transit worse for your health?

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According to the U.S. Census Bureau, nearly 90 percent of the 4.5 million workers in the Los Angeles area spend an average of 60 minutes each day commuting on a roadway or railway. When USC researchers

from the Viterbi School of Engineering set out to study the environmental benefits of different modes of public transit in LA, they found some unexpected results: certain SoCal public transit routes that were entirely underground exposed passengers to greater concentrations of carcinogens in the air. The research was published in *Aerosol and Air Quality Research* on November 29, 2017.

Constantinos Sioutas, the Fred Champion Professor of Civil and Environmental Engineering, and PhD students Christopher Lovett, Farimah Shirmohammadi and Mohammad Sowlat at the USC Viterbi School of Engineering measured particulate matter along the entirety of five popular commuter routes, including major freeways I-110 and I-710, the Metro Red and Gold Lines, as well as surface streets (Wilshire and Sunset Boulevards), representing a variety of traffic and environmental conditions. The researchers chose these particular routes as the 710 is a corridor frequented by largely diesel-fueled commercial trucks transporting cargo from the ports, and the 110, the country's oldest freeway, which allows only non-commercial vehicles along much of its length. The surface streets had a much smaller number of commercial trucks. The Gold Line is above ground light rail, which contrasts with the Red Line, which is older and travels entirely underground.

According to a recent report published in the *Lancet*, air pollution is one of the great killers of our age. Polluted air was responsible in 2015 for approximately 6.5 million deaths worldwide. Particulate matter is considered to be one of the most toxic forms of air pollution. Because of its small size, fine particulate matter less than 2.5 micrometers in diameter (the focus of this study) is able to penetrate deep within the lungs and enter the bloodstream, causing adverse health effects. Two major compounds found in airborne particulate are polycyclic aromatic hydrocarbons (PAHs), caused by incomplete fossil fuel combustion, and transition metals, (e.g. hexavalent chromium) resulting from railway

friction and wear. Both types of compounds include known carcinogens as well as being associated with chronic non-cancer health risks, such as cardiovascular and respiratory distress. The recent work builds on previous research by the Sioutas group in which only polycyclic aromatic hydrocarbons were analyzed along the same transport routes in LA.

The researchers collected air samples using battery-operated devices with particle sensors. On roadways, measurements were taken inside a zero-emissions test vehicle, while for railways, measurements were taken both on train platforms and inside cars, with the assumption that commuters spend approximately 25 percent of their time on the platform and 75 percent on the train. Samples were collected on either Teflon or quartz microfiber filters and analyzed to determine concentrations of polycyclic aromatic hydrocarbons and transition metals. Using cancer potency factors obtained from the EPA and California's Office of Environmental Health Hazard Assessment (OEHHA), cancer and non-cancerous health risks were calculated based on a lifetime of exposure commuting one hour a day, five days a week, for 50 weeks a year, and assuming 30 years of employment.

Results

Even though the electric-powered trains have lower levels of polycyclic aromatic hydrocarbons compared to freeways, and operate with mandatory closed windows and a mechanical ventilation system, the researchers found that the maximum Excess Lifetime Cancer Risk for the Red Line was ten-times higher than the acceptable threshold of one-in-a-million, set by government and health organizations like the World Health Organization (WHO) and the U.S. Environmental Protection Agency (EPA). This was the result of high levels of airborne hexavalent chromium measured within the train cars, likely due to a buildup of dust resulting from friction on the steel tracks, as well as the lack of ventilation on the underground line. It is noted that the Red Line is the

most used of the six LA Metro lines, with approximately 40 percent of the system's total annual ridership.

In contrast, despite some measurable concentration of hexavalent chromium, even inside personal automobiles, the maximum Excess Lifetime Cancer Risk for other measured routes was found to be within the safety threshold. The Metro Gold Line light rail exhibited the lowest exposure concentrations of [hexavalent chromium](#) and [polycyclic aromatic hydrocarbons](#) compared to all other modes of transportation studied.

"What we report is actually the absolute, most protective case scenario for the Red Line," Sioutas said. The Red Line does not have open windows and has a ventilation system, so this prevented even higher concentrations of carcinogens inside the train cars. "The initial premise of our study was to prove that you are better off not driving and instead taking the subway and the light rail. We proved part of the point with the light rail, but we were completely refuted insofar as the Red Line because of the chromium levels," Sioutas said.

The researchers suspect that other underground subway systems around the world may have similarly elevated risk scores. In addition, individuals who spend more time in the subway, particularly those who work there, would have a significantly higher health risk.

"The important thing is to alert the Metropolitan Transportation Authority, without necessarily creating undue panic, to the fact that the exposure levels to chromium and [other] carcinogenic metals are quite elevated, a lot more than would be recommended by, for example, the EPA or any other regulatory authority," Sioutas said.

Provided by University of Southern California

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