

## Subterranean Exploration: Assessing PM<sub>2.5</sub> on Underground Subway Platforms

Lindsey Konkel

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Metropolitan subway systems benefit urban communities by increasing accessibility to speedy, affordable transit while helping to decrease traffic-related air pollution and related health problems.<sup>1</sup> However, subway commuters and transit workers may encounter unique air pollution exposures underground, including high concentrations of fine particulate matter (PM<sub>2.5</sub>).<sup>2,3</sup> In a recent study published in *Environmental Health Perspectives*, investigators led by David Luglio of New York University Langone Health further explored these potential exposures by assessing PM<sub>2.5</sub> concentrations and composition across 12 U.S. subway transit lines.<sup>4</sup>

The researchers measured airborne particles at subway platforms of 71 transit stations in Boston, New York, Philadelphia, and Washington, DC during rush hour. They selected stations from each system based on a variety of criteria, including ridership and previous evidence of high PM<sub>2.5</sub> levels. Average PM<sub>2.5</sub> concentrations were highest underground at the stations serviced by the New York City/New Jersey Port Authority Trans-Hudson (PATH) system, at 779 µg/m<sup>3</sup>. They identified by far the highest concentration—1,499 µg/m<sup>3</sup>—during the morning rush hour at the Christopher Street subway station in Greenwich Village. Concentrations were lowest for the Philadelphia stations, with an average of 112 µg/m<sup>3</sup>.

In some locations they also measured ambient PM<sub>2.5</sub> concentrations aboveground, outside the subway stations, to compare against underground levels. Across all systems, underground concentrations averaged 362 µg/m<sup>3</sup>, compared with an average of 15.1 µg/m<sup>3</sup> aboveground. Even Philadelphia's subway platforms, which had better air quality compared with the other metros, had an average underground PM<sub>2.5</sub> concentration that was nearly nine times the aboveground ambient level.

Rush hour exposures at busy stations such as Christopher Street likely represent worst-case scenarios and may not be typical of exposures at all subway stations at all times of the day, says corresponding study author Terry Gordon, a professor of environmental medicine at New York University Langone Health. However, these worst-case scenarios are important for estimating risk, he says. Future studies should focus on identifying specific station characteristics associated with higher exposures.

Particle composition, which the investigators assessed in a subset of stations, may also be an important factor in assessing health risks and sources of air pollution for abatement efforts. They found differences in the elemental composition of PM<sub>2.5</sub> across the selected stations, although iron and total carbon were



PM<sub>2.5</sub> composition varies widely, depending on the sources present where it is collected. The particles collected on a subset of subway platforms varied dramatically from samples collected outside the stations. Iron made up an average of half the total mass of PM<sub>2.5</sub> collected underground, likely a result of the non-stop grinding of steel wheels against rails. Image: © momente/Shutterstock.

always the two major constituents, accounting for an average 81% of the PM<sub>2.5</sub>.

The high iron content is likely due to friction between the wheels and the rails as well as the wearing away of brake components, Gordon says. High total carbon content is a bit more puzzling, according to Steven Chillrud, a geochemist and exposure scientist at the Columbia University Lamont Doherty Earth Observatory who also has studied subway-related exposures.<sup>3</sup> Subway commuter trains typically are powered by electricity, although diesel combustion from subway maintenance trains may be one potential source. “Further research is needed to better understand where the carbon is coming from,” says Chillrud.

It is not clear what these subway exposures mean for the health of either commuters or transit workers. The PM<sub>2.5</sub> concentrations measured in subway stations during rush hour were about two to seven times the U.S. Environmental Protection Agency 24-hour ambient air safety standard of 35 µg/m<sup>3</sup>.<sup>5</sup> For commuters, these exposures are relatively brief but may represent some of the highest exposures they will encounter during the day. Transit workers, on the other hand, may receive high exposures for much of their workday. However, this study was not designed to assess health risks.

In terms of future health research, Chillrud says a relatively easy first step would be to analyze existing health data for subway transit workers, who may have higher exposures than the

general public. “If evidence was found of health issues in the workers, then it would make sense to do larger worker studies and eventually a study on the general riding public,” he says. “*In vivo* tox studies also would be useful.”

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**Lindsey Konkell** is a New Jersey-based journalist who reports on science, health, and the environment.

## References

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