

# Commuting by subway? What you need to know about air quality

September 15 2017, by Fulvio Amato

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Sao Paulo, Brazil, 2013. Subways abound in fine particles often carried by brakes or trains. Credit: Diego Torres Silvestre/Flickr, CC BY-ND

,[Four more major Indian cities](#) will soon have their own metro lines, the country's government has announced. On the other side of the Himalayas, Shanghai is building [its 14th subway line](#), set to open in 2020, adding 38.5 km and 32 stations to the world's largest subway network. And New Yorkers can finally enjoy their Second Avenue Subway line [after waiting for almost 100 years](#) for it to arrive.

In Europe alone, commuters in more than 60 cities use rail subways. Internationally, more than [120 million people](#) commute by them every day. We count around [4.8 million](#) riders per day in London, [5.3 million](#) in Paris, [6.8 million](#) in Tokyo, [9.7 million](#) in Moscow and [10 million](#) in Beijing.

Subways are vital for commuting in crowded cities, something that will become more and more important over time – according to a United Nations 2014 report, [half of the world's population is now urban](#). They can also play a part in reducing outdoor air pollution in large metropolises by helping to reduce motor-vehicle use.

Large amounts of breathable particles (particulate matter, or PM) and nitrogen dioxide (NO<sub>2</sub>), produced in part by industrial emissions and road traffic, [are responsible](#) for shortening the lifespans of city dwellers. Public transportation systems such as subways have thus seemed like a solution to reduce air pollution in the urban environment.

But what is the air like that we breathe underground, on the rail platforms and inside trains?

## **Mixed air quality**

Over the last decade, several [pioneering studies](#) have monitored subway air quality across a range of cities in Europe, Asia and the Americas. The database is incomplete, but is growing and is already valuable.

For example, comparing air quality on subway, bus, tram and walking journeys from the same origin to the same destination in [Barcelona](#), revealed that subway air had higher levels of air pollution than in trams or walking in the street, but slightly lower than those in buses. Similar lower values for subway environments compared to other public transport modes have been demonstrated by studies in [Hong Kong](#),

[Mexico City](#), [Istanbul](#) and [Santiago de Chile](#).

## Of wheels and brakes

Such [differences](#) have been attributed to different wheel materials and braking mechanisms, as well as to variations in [ventilation](#) and air conditioning systems, but may also relate to differences in measurement campaign protocols and choice of sampling sites.

Key factors influencing subway air pollution will include station depth, date of construction, type of ventilation (natural/air conditioning), types of brakes (electromagnetic or conventional brake pads) and wheels (rubber or steel) used on the trains, train frequency and more recently the presence or absence of platform screen-door systems.



Second Avenue Subway in the making, New York, 2013. Credit: MTA Capital Construction/Rehema Trimiew/Wikimedia, CC BY-SA

In particular, much subway particulate matter is sourced from moving train parts such as wheels and brake pads, as well as from the steel rails and power-supply materials, making the particles dominantly iron-containing.

To date, there is no clear epidemiological indication of abnormal health effects on underground workers and commuters. [New York subway workers](#) have been exposed to such air without significant observed impacts on their health, and no increased risk of lung cancer was found among subway train drivers in the [Stockholm subway system](#).

But a note of caution is struck by the observations of [scholars](#) who found that employees working on the platforms of Stockholm underground, where PM concentrations were greatest, tended to have higher levels of risk markers for cardiovascular disease than ticket sellers and train drivers.

The dominantly ferrous particles are mixed with [particles from a range of other sources](#), including rock ballast from the track, biological aerosols (such as bacteria and viruses), and air from the outdoors, and driven through the tunnel system on turbulent air currents generated by the trains themselves and ventilation systems.

## Comparing platforms

The most extensive measurement programme on subway platforms to date has been carried out in the Barcelona subway system, where 30 stations with differing designs were studied under the frame of [IMPROVE LIFE project](#) with additional support from the AXA Research Fund.

It reveals substantial variations in [particle-matter concentrations](#). The stations with just a single tunnel with one rail track separated from the platform by glass barrier systems showed on average half the concentration of such particles in comparison with conventional stations, which have no barrier between the platform and tracks. The use of [air-conditioning](#) has been shown to produce lower particle-matter concentrations inside carriages.

In trains where it is possible to open the windows, such as [in Athens](#), concentrations can be shown generally to increase inside the train when passing through tunnels and more specifically when the train enters the tunnel at [high speed](#).

## **Monitoring stations**

Although there are no existing legal controls on air quality in the subway environment, research should be moving towards realistic methods of mitigating particle pollution. Our experience in the [Barcelona subway system](#), with its considerable range of different station designs and operating ventilation systems, is that each platform has its own specific atmospheric micro environment.

To design solutions, one will need to take into account local conditions of each station. Only then can researchers assess the influences of pollution generated from moving train parts.

Such research is still growing and will increase as [subway](#) operating companies are now more aware about how cleaner air leads directly to better health for city commuters.

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