One-page summary

High concentrations of particulate matter have been measured in several subway networks worldwide. The results from these studies raise concerns about the potential adverse health effects for both passengers and Metro workers. In Stockholm, Sweden, commuting by subway is a popular mode of transportation, making it relevant to investigate commuter exposure to particulate matter. Especially particles below the size of 2.5 microns (PM2.5) or 0.1 microns (UFP) can penetrate deep into the respiratory system and spread throughout the body. With this background, the research questions of this study were: (1) How do the PM2.5 mass and UFP number concentrations differ between stations on the Green Line in the Stockholm subway? (2) Do the PM2.5 levels exceed the recommended WHO air quality guidelines?

PM2.5 mass and UFP number concentrations were measured at 20 stations along the Green Line in the Stockholm subway. Measurements were taken using sensors mounted on two boards, by repeatedly jumping on and off the platforms. The positions and times at the stations were logged with a custom mobile application. This data was combined with the sensor data and analyzed in subsequent data analysis. A series of additional measurements and experiments were also made in an extensive statistical analysis to evaluate 1) the reliability of the measuring equipment and 2) the implications of the recorded values. This analysis further strengthened the results.

It was found that indoor stations had significantly higher PM2.5 levels and bigger PM2.5 particles than outdoor stations. Indoor stations Hötorget, T-Centralen, and Rådmansgatan had the highest PM2.5 means. The results were compared to the WHO Air Quality Guidelines, and several stations in the Stockholm subway likely exceed the annual and 24-hour PM2.5 reference values. The highest UFP number concentrations were recorded at outdoor stations Kristineberg, Thorildsplan, and Gullmarsplan.

Addressing the first research question, there seem to be significant differences in particle concentrations between subway platforms. The results highlight some differences between outdoor and indoor stations. Indoor stations generally had larger PM2.5 particles, contributing to higher PM2.5 readings. Outdoor stations had lower PM2.5 levels. However, some outdoor stations showed greater UFP number counts and, therefore, contained higher concentrations of smaller particles. Station design, tunnel length, and material choice are all factors that could influence PM levels. Further research investigating the particle composition and size distributions at these platforms could give important insights. Also, longer measurement campaigns across multiple seasons could help distinguish seasonal effects.

The health effects related to particulate matter are yet to be fully understood. However, the findings from this study, in conjunction with previously published literature, suggest that subway air pollution is a topic that cannot go unnoticed. As mentioned in the updated WHO air quality guidelines, particle pollution is causing harm at even lower levels than previously believed. Regarding the second research question, it is likely that stations in the Stockholm subway exceed the 5 and 15 $\mu g/m^3$ WHO PM2.5 reference values, and require further investigation. WHO notes that all efforts to mitigate air pollution will benefit public health. Therefore, all research into reduction strategies is encouraged. These findings highlight the importance of investigating subway air quality and could aid future research into this relevant topic.