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Commuting on the London Underground and Long-term Health Outcomes: A Cohort Study Using Externally Linked Census Data

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Background

Metro systems are essential for urban mobility but often expose commuters to particulate matter (PM) at levels far above roadside air. The London Underground (LU), the world's oldest metro, supports ~4 million daily journeys and has elevated PM_{2.5} concentrations dominated by iron-rich particles from mechanical abrasion. These exposures raise concerns about long-term health effects.

peared slightly elevated, though uncertainty remains. Findings highlight the need for better exposure assessment and further research on metro-related PM.

Methods

Using the Office for National Statistics Longitudinal Study (ONS-LS), we analysed two retrospective cohorts of economically active adults (≥ 16 years) living and working in London and recorded in the 1991, 2001, or 2011 Censuses. Cohort 1 ($n = 7,343$) compared LU commuters with above-ground rail users. Cohort 2 ($n = 4,094$) examined dose—response patterns between externally linked cumulative LU PM_{2.5} exposure and health outcomes. Exposure estimates combined Transport for London data, PM_{2.5} measurements, and geospatial modelling. Outcomes were all-cause mortality (1991 to 2017) and cancer incidence (1991 to 2015). Analyses used inverse probability weighting and the parametric g-formula.

Results

Most LU commuters were estimated to encounter hourly PM_{2.5} levels $> 100 \mu\text{g}/\text{m}^3$. LU users were 1.93% (95% CI: 0.58–3.66) less likely to survive the follow-up period than above-ground rail users, while cancer risk differences were negligible. No dose—response pattern emerged, and a hypothetical 50% PM_{2.5} reduction produced minimal survival change.

Conclusions

LU commuters experience PM_{2.5} concentrations roughly 8–10 times higher than above-ground levels. Mortality risk ap-

