

Absentee and Economic Impact of Low-Level Fine Particulate and Ozone Exposure in K-12 Students

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Abstract

Importance: High air pollution levels are associated with school absences. However, low level pollution impact on individual school absences are under-studied. Positive local findings could improve school recess decisions, better identify pollution sources and improve local economic effects assessments.

Objective: To quantify PM_{2.5} and ozone exposure impacts on school absences and the local economy.

Design: We modelled PM_{2.5} and ozone concentrations at 36 schools from July 2015 to June 2018 using data from a dense, research grade regulatory sensor network. We determined exposures and daily absences at each school. We used generalized estimating equations model to retrospectively estimate rate ratios for association between outdoor pollutant concentrations and school absences. We estimated lost school revenue, productivity and family economic burden.

Setting: Salt Lake City School District, Salt Lake County, Utah, USA.

Participants: Individual schools in the Salt Lake City School District.

Exposures: PM_{2.5} and ozone.

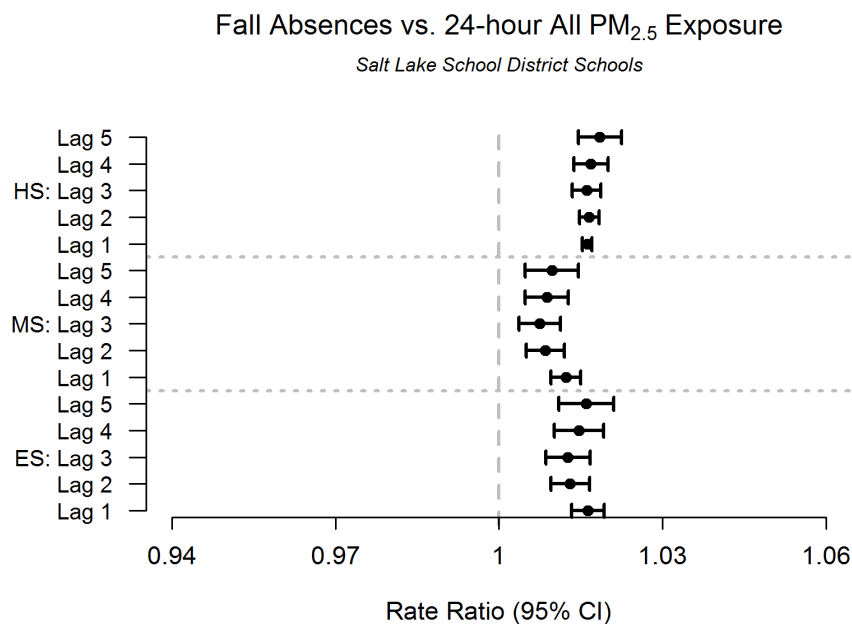
Main Outcomes: Rate ratios for subsequent day absences from PM_{2.5} and ozone exposures at each school and local economic losses.

Results: PM_{2.5} and ozone concentrations and absence rates vary across the School District.

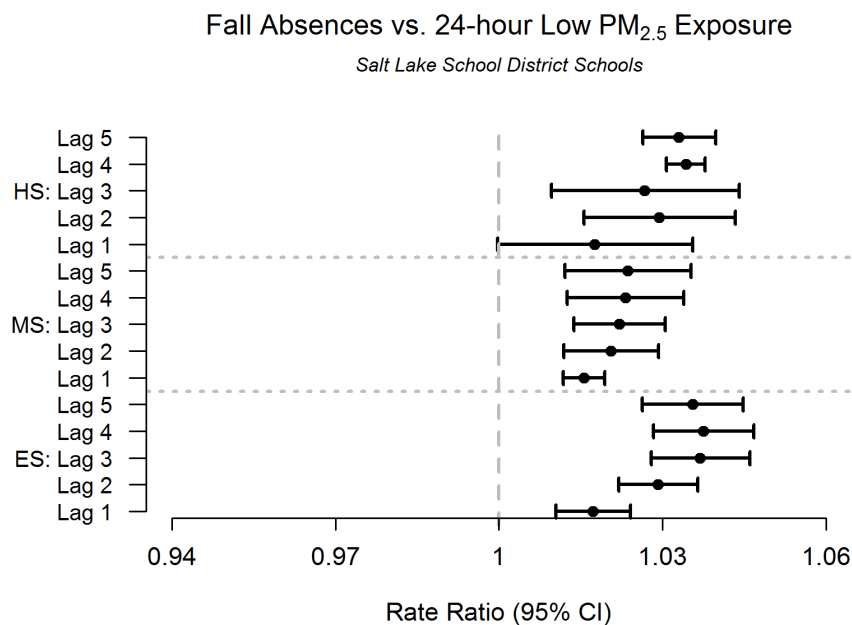
Pollution exposure were associated with as high a rate ratio of 1.02 absences per $\mu\text{g}/\text{m}^3$ and 1.01 per ppb increase for PM_{2.5} and ozone, respectively. Significantly, even PM_{2.5} and ozone exposure below regulatory standards ($< 12.1 \mu\text{g}/\text{m}^3$ and $< 55 \text{ ppb}$) was associated with positive rate ratios of absences: 1.04 per $\mu\text{g}/\text{m}^3$ and 1.01 per ppb increase, respectively. Granular local

measurements enabled demonstration of air pollution impacts that varied between schools undetectable with averaged pollution levels. Reducing pollution by 50% would save \$452,000 per year districtwide. Pollution reduction benefits would be greatest in schools located in socioeconomically disadvantaged areas.

Conclusions and Relevance: Exposures to air pollution, even at low levels, are associated with increased school absences. Heterogeneity in exposure, disproportionately affecting socioeconomically disadvantaged schools, points to the need for fine resolution exposure estimation. The economic cost of absences associated with air pollution is substantial even excluding indirect costs such as hospital visits and medication. These findings may help inform decisions about recess during severe pollution events and regulatory considerations for localized pollution sources.



A



B

Figure 1. Association between absences and lagged fine particulate matter (PM_{2.5}) exposure during the fall
 Rate ratios of Salt Lake City School District fall (September-November) absences associated with lagged fine particulate matter (PM_{2.5}) exposure for: A) all concentration levels and B) low (<12.1 µg/m³) concentration levels.