Supplemental Digital Content

Traffic-related air pollution and attention in primary school children: short-term association
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eAppendix. Indoor pollutant levels in the classroom

We built predictive models for indoor air pollution in classrooms using linear mixed regression models. The dependent variable was repeat measures of indoor levels of the pollutant (two sampling campaigns). The independent variables were floor level (Ground or 1st; 2nd; and 3rd or higher), room orientation (classroom oriented towards: indoor area, outdoor playground, or directly onto the street), outdoor levels of the pollutant, seasonal and weather determinants such as temperature, relative humidity and rainfall. We first performed a univariate analysis of all variables, including an evaluation of their normality. Second, we assessed the linearity of the relationship between indoor and outdoor levels of air pollutants and weather-related variables using generalized additive models. If there was evidence of a non-linear relationship, we tested for a curvilinear association based on the significance of the squared term of the independent variable. Third, we introduced the variables consecutively into the multivariate model in order of highest to lowest R², provided that they added more than 1% to the R² and maintained the expected direction in the association. We then applied backward regression, retaining variables with a p-value of < 0.1.

Regression diagnostics tests included normality of residuals, homoscedasticity, and influential data points. We assessed model performance in the three ways. i) leave-one-out cross-validation (LOOCV), obtaining three measures of goodness-of-fit: the LOOCV R² (pseudo R², the square of the coefficient of correlation between the predicted and observed values of each air pollutant), LOOCV RMSE (the Root Mean Square Error: the standard deviation of the residuals), and LOOCV MAE (the Mean Absolute Error: the average of the absolute values of the residuals); ii) computing the Fraction Bias (FB), NMSE (the Normalized Mean Square Error) and FAC2 (the Factor of 2, defined as the ratios of model prediction to observed values that are ≥0.5 and ≤2). The model was considered acceptable if FAC2>0.5, |FB|<0.3, and NMSE<1.5; and iii) comparing predicted levels of the modeled pollutant to sampled levels at sites not included in the prediction model (only available for NO₂). Modeled levels of NO₂ had very good validity (correlation coef. = 0.94) against a subset (n=19) of NO₂ measurements conducted simultaneously in different classrooms of six schools. Finally, we then predicted levels of indoor pollution for all the classrooms using the parameter estimates derived from the regression model.
**eTable 1.** Short-term and long-term NO2 and EC relationship with children and daily characteristics.

<table>
<thead>
<tr>
<th></th>
<th>Short term exposure</th>
<th>Long term exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NO₂</td>
<td>EC</td>
</tr>
<tr>
<td><strong>Spearman correlations</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Covariates</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>-0.05</td>
<td>-0.07</td>
</tr>
<tr>
<td>Home SES vulnerability index</td>
<td>-0.03</td>
<td>-0.03</td>
</tr>
<tr>
<td>Home air pollution (LUR)</td>
<td>-0.05</td>
<td>-0.04</td>
</tr>
<tr>
<td>Noise</td>
<td>0.07</td>
<td>0.02</td>
</tr>
<tr>
<td><strong>Daily characteristics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>0.07</td>
<td>0.06</td>
</tr>
<tr>
<td>Relative Humidity</td>
<td>0.14</td>
<td>0.39</td>
</tr>
<tr>
<td><strong>Pollutant mean (sd) - µg/m³</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Covariates</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>37.7 (18.3)</td>
<td>1.34 (0.84)</td>
</tr>
<tr>
<td>Boys</td>
<td>37.8 (18.3)</td>
<td>1.33 (0.83)</td>
</tr>
<tr>
<td>Maternal Education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>38.0 (18.2)</td>
<td>1.36 (0.82)</td>
</tr>
<tr>
<td>Medium-Low</td>
<td>37.4 (18.7)</td>
<td>1.31 (0.86)</td>
</tr>
<tr>
<td><strong>Daily characteristics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Season</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warm</td>
<td>35.3 (19.8)</td>
<td>1.10 (0.70)</td>
</tr>
<tr>
<td>Cold</td>
<td>39.3 (17.3)</td>
<td>1.47 (0.88)</td>
</tr>
<tr>
<td>Period</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year 1</td>
<td>37.6 (19.6)</td>
<td>1.29 (0.84)</td>
</tr>
<tr>
<td>Year 2</td>
<td>37.9 (16.6)</td>
<td>1.40 (0.83)</td>
</tr>
<tr>
<td>Day of the week</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monday</td>
<td>31.7 (13.5)</td>
<td>0.99 (0.55)</td>
</tr>
<tr>
<td>Tuesday</td>
<td>34.5 (16.9)</td>
<td>1.13 (0.73)</td>
</tr>
<tr>
<td>Wednesday</td>
<td>40.9 (20.8)</td>
<td>1.62 (0.93)</td>
</tr>
<tr>
<td>Thursday</td>
<td>43.9 (19.9)</td>
<td>1.52 (0.89)</td>
</tr>
<tr>
<td>Friday</td>
<td>36.7 (16.9)</td>
<td>1.39 (0.84)</td>
</tr>
<tr>
<td>Hour of exam</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8h-11h</td>
<td>37.6 (18.4)</td>
<td>1.31 (0.84)</td>
</tr>
<tr>
<td>11h-13h</td>
<td>37.7 (19.4)</td>
<td>1.37 (0.87)</td>
</tr>
<tr>
<td>15h-17h</td>
<td>37.1 (15.8)</td>
<td>1.31 (0.78)</td>
</tr>
</tbody>
</table>

SES: socio-economic status based on the neighbourhood vulnerability index; LUR: Land Use Regression
eTable 2. Association (difference per interquartile range increase, ) between daily variation (short-term) and indoor classroom levels (long-term) of traffic-related air pollution and daily cognitive function.

<table>
<thead>
<tr>
<th></th>
<th>Short-term</th>
<th>Long-term</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Lag 1)(^a)</td>
<td>(^b)</td>
</tr>
<tr>
<td><strong>NO(_2)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superior WM (three-back numbers, d');</td>
<td>-1.24 (-4.25, 1.76)</td>
<td>-2.81 (-8.19, 2.56)</td>
</tr>
<tr>
<td>WM (two-back words, d');</td>
<td>-1.55 (-5.38, 2.28)</td>
<td>-6.52* (-11.87, -1.17)</td>
</tr>
<tr>
<td>Superior WM (three-back words, d');</td>
<td>0.93 (-2.16, 4.02)</td>
<td>-2.20 (-7.35, 2.95)</td>
</tr>
<tr>
<td><strong>EC</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superior WM (three-back numbers, d');</td>
<td>-0.54 (-3.57, 2.49)</td>
<td>-3.07 (-7.90, 1.77)</td>
</tr>
<tr>
<td>WM (two-back words, d');</td>
<td>1.92 (-1.87, 5.71)</td>
<td>-2.25 (-7.57, 3.06)</td>
</tr>
<tr>
<td>Superior WM (three-back words, d');</td>
<td>1.36 (-1.71, 4.44)</td>
<td>0.02 (-4.63, 4.67)</td>
</tr>
</tbody>
</table>

Short-term adjusted for long-term\(^c\)

<table>
<thead>
<tr>
<th></th>
<th>Short-term</th>
<th>Long-term</th>
</tr>
</thead>
</table>

WM: Working Memory; d': detectability; EC: Elemental Carbon; NO\(_2\): Nitrogen Dioxide

\(^a\) Lag 1 = exposure of the day before of the attention test, model adjusted (cubic spline) for temperature and relative humidity on the current day, season (cold, warm), day of the week and period (year 1 or 2), hour of exam.

\(^b\) Adjusted for child's age, sex, maternal education, socioeconomic status of the neighborhood of residence, and home air pollution.

\(^c\) Adjusted for\(^a\) and \(^b\) above.

* \(p < 0.05\)
### eTable 3. Sensitivity analyses of the association (difference per interquartile range increase,) between daily variation (acute effects) of traffic-related air pollution and daily cognitive function.

<table>
<thead>
<tr>
<th></th>
<th>Unadjusted</th>
<th>Fixed effects per individual&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Temporal trend pre-adjustment&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inattention</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean HRT, ms;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO₂</td>
<td>24.52* (21.36 , 27.69)</td>
<td>5.30* (2.62 , 7.98)</td>
<td>10.43* (6.14 , 14.71)</td>
</tr>
<tr>
<td>EC</td>
<td>23.68* (20.52 , 26.85)</td>
<td>10.20* (7.15 , 13.25)</td>
<td>6.26* (2.24 , 10.28)</td>
</tr>
<tr>
<td>HRT-SE, ms;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO₂</td>
<td>8.02* (6.16 , 9.88)</td>
<td>2.33* (0.61 , 4.05)</td>
<td>3.14* (0.66 , 5.62)</td>
</tr>
<tr>
<td>EC</td>
<td>6.43* (4.56 , 8.30)</td>
<td>2.85* (0.88 , 4.83)</td>
<td>1.24 (-1.10 , 3.58)</td>
</tr>
<tr>
<td><strong>Number of Omissions;</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO₂</td>
<td>14%* (10% , 18%)</td>
<td>5%* (1% , 8%)</td>
<td>7%* (2% , 13%)</td>
</tr>
<tr>
<td>EC</td>
<td>7%* (4% , 11%)</td>
<td>4%* (0% , 8%)</td>
<td>2% (-4% , 7%)</td>
</tr>
<tr>
<td><strong>Number of Commissions;</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO₂</td>
<td>8%* (3% , 13%)</td>
<td>1% (-1% , 4%)</td>
<td>10%* (0% , 22%)</td>
</tr>
<tr>
<td>EC</td>
<td>2% (-2% , 7%)</td>
<td>3%* (0% , 6%)</td>
<td>7% (-3% , 18%)</td>
</tr>
<tr>
<td><strong>Working memory</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two-back numbers, d'x100;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO₂</td>
<td>-3.67* (-6.94 , -0.39)</td>
<td>-1.62 (-4.84 , 1.61)</td>
<td>-0.06 (-4.26 , 4.14)</td>
</tr>
<tr>
<td>EC</td>
<td>-3.30 (-6.61 , 0.01)</td>
<td>0.08 (-3.58 , 3.74)</td>
<td>0.54 (-3.58 , 4.65)</td>
</tr>
</tbody>
</table>

HRT: Hit Reaction Time; SE: Standard error; ms: milliseconds; RR: Rate ratio; d': detectability; EC: Elemental Carbon; NO₂: Nitrogen Dioxide

<sup>a</sup> Adjusted for temperature on the current day (linear and quadratic term), relative humidity on the current day, season (cold, warm), day of the week and period (year 1 or 2), hour of exam, and fixed-effect for subject.

<sup>b</sup> Pre-adjusted exposures were used as explained elsewhere (26). GAM models for the air pollutant as a function of day of the week, season, and smooth terms for time (7 df/year), temperature (3 df) and relative humidity (3 df for NO2 and 1 df for BC) were fitted. Residuals were adjusted for period (year 1 or 2), hour of exam.

*<sup>p < 0.05</sup>
**eTable 4.** Stratified analyses\(^a\) of the association (difference per interquartile range increase) between daily variation (short-term) of traffic-related air pollution and daily cognitive function.

<table>
<thead>
<tr>
<th></th>
<th>By sex (n=1,343)</th>
<th>By Maternal Education</th>
<th>By ADHD (n=2,382)</th>
<th>By ADHD (n=274)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Boys</td>
<td>Girls</td>
<td>High (n=1,575)</td>
<td>Low-Middle (n=1,112)</td>
</tr>
<tr>
<td><strong>Mean HRT, ms;</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO(_2)</td>
<td>16.78* (12.08 , 21.47)</td>
<td>14.01* (8.84 , 19.19)</td>
<td>13.13* (8.76 , 17.50)</td>
<td>17.61* (11.81 , 23.42)</td>
</tr>
<tr>
<td>EC</td>
<td>10.13* (5.66 , 14.59)</td>
<td>9.65* (4.89 , 14.41)</td>
<td>10.05* (6.01 , 14.09)</td>
<td>8.74* (3.18 , 14.29)</td>
</tr>
<tr>
<td><strong>HRT-SE, ms;</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO(_2)</td>
<td>5.60* (2.48 , 8.71)</td>
<td>4.38* (1.16 , 7.61)</td>
<td>3.98* (1.18 , 6.78)</td>
<td>5.71* (2.04 , 9.38)</td>
</tr>
<tr>
<td>EC</td>
<td>1.81 (-1.17 , 4.80)</td>
<td>3.05* (0.02 , 6.08)</td>
<td>2.52 (-0.09 , 5.14)</td>
<td>2.28 (-1.29 , 5.86)</td>
</tr>
<tr>
<td><strong>Number of Omissions;</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO(_2)</td>
<td>8%* (2%, 15%)</td>
<td>7%* (1%, 13%)</td>
<td>5% (-1%, 11%)</td>
<td>10%* (3%, 17%)</td>
</tr>
<tr>
<td>EC</td>
<td>5% (0%, 11%)</td>
<td>1% (-4%, 7%)</td>
<td>4% (-1%, 9%)</td>
<td>3% (-3%, 9%)</td>
</tr>
<tr>
<td><strong>Number of Comissions;</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO(_2)</td>
<td>13%* (5%, 22%)</td>
<td>17%* (8%, 27%)</td>
<td>27%* (19%, 37%)</td>
<td>4% (-4%, 13%)</td>
</tr>
<tr>
<td>EC</td>
<td>13% (-4%, 11%)</td>
<td>16%* (8%, 25%)</td>
<td>12%* (5%, 20%)</td>
<td>4% (-4%, 13%)</td>
</tr>
<tr>
<td><strong>Two-back numbers, d';</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO(_2)</td>
<td>-1.47 (-6.78 , 3.83)</td>
<td>-1.43 (-6.76 , 3.89)</td>
<td>-2.99 (-7.93 , 1.94)</td>
<td>-0.59 (-6.30 , 5.11)</td>
</tr>
<tr>
<td>EC</td>
<td>0.37 (-4.89 , 5.63)</td>
<td>0.76 (-4.44 , 5.97)</td>
<td>0.23 (-4.50 , 4.97)</td>
<td>-0.24 (-6.07 , 5.60)</td>
</tr>
</tbody>
</table>

\(^a\) Adjusted (cubic spline) for temperature and relative humidity on the current day, season (cold, warm), day of the week and period (year 1 or 2), hour of exam.

\(^p < 0.05\)
eTable 5. Stratified analyses\(^a\) of the association (differenced per interquartile range increase) between daily variation (short-term) of traffic-related air pollution and daily cognitive function.

<table>
<thead>
<tr>
<th></th>
<th>By season</th>
<th>By noise</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cold (N=2,647)</td>
<td>Warm (N=2,616)</td>
</tr>
<tr>
<td><strong>Mean HRT, ms;</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EC</td>
<td>0.55 (-4.64 , 5.75)</td>
<td>17.22* (10.09 , 24.36)</td>
</tr>
<tr>
<td><strong>HRT-SE, ms;</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO(_2)</td>
<td>2.12 (-1.43 , 5.66)</td>
<td>1.92 (-2.82 , 6.67)</td>
</tr>
<tr>
<td>EC</td>
<td>0.11 (-3.31 , 3.53)</td>
<td>3.24 (-1.67 , 8.15)</td>
</tr>
<tr>
<td><strong>Number of Omissions;</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO(_2)</td>
<td>7%* (1% , 4%)</td>
<td>-7% (-15% , 1%)</td>
</tr>
<tr>
<td>EC</td>
<td>0% (-6% , 6%)</td>
<td>2% (-7% , 12%)</td>
</tr>
<tr>
<td><strong>Number of Commissions;</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO(_2)</td>
<td>7% (-1% , 15%)</td>
<td>15%* (5% , 26%)</td>
</tr>
<tr>
<td>EC</td>
<td>-3% (-11% , 5%)</td>
<td>32%* (21% , 45%)</td>
</tr>
<tr>
<td><strong>Two-back numbers, d’,</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO(_2)</td>
<td>0.60 (-4.93 , 6.13)</td>
<td>0.80 (-6.69 , 8.28)</td>
</tr>
<tr>
<td>EC</td>
<td>4.11 (-1.28 , 9.49)</td>
<td>2.34 (-5.42 , 10.10)</td>
</tr>
</tbody>
</table>

\(^a\) Adjusted for (cubic spline) for temperature and relative humidity on the current day, season (cold, warm), day of the week and period (year 1 or 2), hour of exam.

\(^*\) p < 0.05
eFigure 1 Association (difference per interquartile range increase, IQR) between ambient daily levels (short-term by lag period) and indoor classroom levels (long-term) of NO2 and inattention: (A) number of comissions and B) mean HRT.

Legend: Lag 0: same day exposure, Lag 1: day before exposure, Lag 2: two days before exposure.

- Models were adjusted (cubic spline) for the temperature and relative humidity on the current day, season (cold, warm), day of the week, period (year 1 or 2), and the hour of the exam. Subject nested in classroom, and classroom nested in school.
- Adjusted as for the above, plus child's age, sex, maternal educational level, socioeconomic status of the neighborhood of residence, home air pollution and indoor air pollution in the classroom.
- Indoor estimate from the 1-day lag model.