THE EFFECT OF ULTRAFINE PARTICLES FROM TRAFFIC EMISSIONS ON CHILDREN’S HEALTH (UPTECH)

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1. Introduction
Currently there is a limited body of epidemiological data on the effects of ultrafine (UF) particles (<0.1 µm) on human health, particularly children. This project seeks to determine the effect of exposure to airborne UF particles emitted from motor vehicles on the health of school children. To achieve this, air quality and clinical data will be collected at 25 primary schools in the Brisbane Metropolitan Area (BMA), Queensland, Australia, over the next two years (five schools have already been tested to date).

2. Methods
This cross-sectional study focuses on spatial variation in the relationship between exposure-health outcomes, among children aged 8-11 years. The main hypothesis which is being tested is that variations in long-term exposure to UF particles are associated with variations in specified respiratory, inflammation and endothelial attributes. The study targets the long-term rather than short-term health effects of exposure to UF particles.

Randomly selected state schools in the BMA that meet the selection criteria were considered eligible (classrooms used by 8-11 year olds are naturally ventilated, no major local air pollution sources, other than road traffic).

A questionnaire was developed, to describe the study population, respiratory symptoms, general health status, and housing conditions, exposure to environmental tobacco smoke and ethnicity.

Details of the study design, which were assessed by the International Scientific Advisory Committee for this project, are available at: http://www.ilaqh.gut.edu.au/Misc/UPTECH%20Home.htm.

2.1. Air Quality
Air quality data will be collected continuously at 5 sampling locations within the school grounds for two weeks at each school: 3 outdoor (A, B and C) and 2 indoor sites (D and E). The outdoor sites are selected across the school grounds to estimate the exposure profile with respect to the distance from the nearest road. Outdoor site, B, was selected to represent the overall exposure within the school, as best as possible.

Particle number concentration (PNC) will be measured at all 5 sites, while other parameters will also be measured at Site B, including particle size distribution in the submicrometer range (10 - 400 nm); particle surface area; elemental and organic carbon (EC, OC) in PM$_{2.5}$; elemental composition of PM$_{1}$ and PM$_{2.5}$ volatile organic compounds (VOC); PAHs; carbonyls; particle mass (PM$_{10}$, PM$_{2.5}$ and PM$_{1}$); NO$_x$, CO; ions; culturable moulds; and meteorological conditions. Indoor sites will also be sampled for carbonyls; VOC; CO$_2$; culturable moulds; endotoxins; and total bacteria. Classroom activities and characteristics will be monitored for moisture damage, cleanliness and other aerosol sources, using an activity diary. Traffic counts and vehicle speciation will also be measured at each school.

At least three children, who consented to participate in the study, will be asked to carry a personal particle number counter (Philips - NanoTracer) and a GPS for 24 hours. Each child and their parents/guardians will be asked to record their travel and activities during school and non-school hours, as well as any time when the sampler is not with the child throughout the measurement period.

2.2. Clinical Measures
About 20 children will be tested in each school and the tests include pre and post bronchodilator spirometry, skin prick test for common airborne allergens, multiple breath nitrogen washouts (MBNW), forced oscillation technique (FOT) and exhaled nitric oxide (eNO). Each child will spend approximately 2.5 hours undergoing these tests.

3. Results and Discussion
The first five schools were tested during October 2010 to April 2011 and the data collected at the 5 schools are currently being processed.

3.1. Air Quality
In the first instance, correlations between different air pollutants at the school will be investigated, including the time series of UF PNC at the 5 sampling locations. These time series will be used to determine the potential indoor or outdoor sources (Figure 1). High correlations between the measured data at indoor and outdoor locations imply that traffic emissions are the main source of UF particles in the classrooms. However, occasional incursions indicate the presence of indoor sources. High spatial variations were observed in the measured PNC in some of the schools, showing the effect of local traffic and meteorological conditions. Preliminary conclusions of the chemical analyses include: the schools with lower OC/EC (a marker for diesel emissions) and higher concentrations of traffic related elements are more influenced by traffic emissions. At these schools, there were high correlations between the traffic counts and UF PNCs.

Figure 1. Indoor and outdoor UF particle concentrations at a school.

3.2. Clinical Measures
A total of 116 out of the 295 children approached in the 5 schools agreed to participate in the study. Analyses of the questionnaire data in the first 3 schools showed that 53% of the children were atopic, 11% were exposed to indoor tobacco smoke at home, half of the households used gas for cooking and 28% of the children walked to school, while 62% rode in a car. Table 1 shows the spirometry and eNO results for the first 3 schools.

Table 1 - UPTECH Spirometry and eNO

<table>
<thead>
<tr>
<th>Spirometry</th>
<th>n=108 (pre) 104 (post)</th>
<th>Mean</th>
<th>95%CI</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEV₁, pre-bd (L)</td>
<td>1.9</td>
<td>1.8-2.0</td>
<td>1.1-2.7</td>
<td></td>
</tr>
<tr>
<td>FEV₁, post-bd (L)</td>
<td>1.9</td>
<td>1.9-2.0</td>
<td>1.2-2.8</td>
<td></td>
</tr>
<tr>
<td>FVC, pre-bd (L)</td>
<td>2.2</td>
<td>2.1-2.3</td>
<td>1.3-3.3</td>
<td></td>
</tr>
<tr>
<td>FVC, post-bd (L)</td>
<td>2.2</td>
<td>2.1-2.2</td>
<td>1.3-3.1</td>
<td></td>
</tr>
<tr>
<td>FEV₁ / FVC, pre-bd</td>
<td>0.86</td>
<td>0.84-0.87</td>
<td>0.6-0.98</td>
<td></td>
</tr>
<tr>
<td>FEV₁ / FVC, post-bd</td>
<td>0.89</td>
<td>0.88-0.91</td>
<td>0.77-1.0</td>
<td></td>
</tr>
</tbody>
</table>

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