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Air Pollution, Pregnancy Smoking exposure and Child Health Risk Estimation using Merseyside Community Child Health and Air Pollution Data

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Statement of the problem: Air pollution is a serious public health issue that can lead to child health problems. The environmental exposures have been well documented in Sefton area with increased concern and interest among communities about air pollution near to the Bootle Dock area. Smoking during pregnancy has detrimental effects for the mother as well as the fetus. It increases the risk of intrauterine growth restriction (IUGR), obstetric complications and other adverse health effects and is one of the avoidable causes of low birthweight or pre-term birth, with significant associated fetal and infant mortality and morbidity. Rationale: There is need to improve children's environmental health indicators using existing information and to identify knowledge gaps and risk groups for developing new policies. Linkage and analysis of data from various currently available sources for developing modern methods with practical utility provides a tool for future application of risk profiling.

Aim: To develop and establish a combined database of pollution indicators, cigarette smoke exposure and health variables using the Sefton Community Child Health Survey as a resource for a descriptive analysis of environmental factors and child health.

Objectives: (1) To compute risk estimates for adverse birth and child health outcomes in relation to levels of PM10, NO2, concentrations and pregnancy smoking categories and to estimate mean emissions for NOX and PM10, and mean concentrations for PM10 and NO2 in areas with high and low prevalence of adverse birth and child health outcomes (2)To develop Venn diagrams and Spatial maps of health risk profiles of public health importance for potential use in child health promotion in the Sefton Merseyside area.

Methodology: A retrospective cross-sectional study was conducted linking the Community Child Health Survey in 2006 to the air pollution data from Sefton area using post codes sectors (3 digits). Data for the Child health survey was collected using pre-tested standardised questionnaires which were distributed to the school children and returned back after completion by parents at home. PM10 and NOx monitoring data was available as total and average emissions measured in tonnes per annum and NO2 and PM10 concentrations data in microgram per m3. Height was measured to the nearest millimetre using a Minimeter scale (Raven Equipment limited), which was placed against a vertical surface in the school building. Height was measured in duplicate with the child standing erect by the same observer in all surveys and the highest height measurement recorded. Weight was measured to the nearest 100 grams using electronic scales (Seca). These scales were pre calibrated and the weight checked against the investigators weight prior to each survey. A school re-visit was made to measure absentees and to distribute a second questionnaire to non-responders. If these were returned a further visit was made to measure these children.

Analysis of data was conducted using SPSS 20 for univariate analysis and backward stepwise logistic regression, and results were illustrated using the Venn diagrams and spatial mapping techniques with trial of Structural Equation modelling. Population attributable risk estimates and their 95% confidence intervals (95% CI) for health outcomes, defined in relation to these categories of pollution emissions and concentrations data, were calculated. Significant maternal and child health outcomes from the univariate analysis ($p<0.05$) were included in the population attributable risk estimates. Odds ratios and adjusted odds ratios were used for risk estimates. Variables included air pollution in Sefton was monitored using real-time air pollution monitors and airborne particle monitors to measure PM10 emissions and passive diffusion tubes to measure oxides of nitrogen. Outcome variables included birth and child health outcomes and exposure variables included air pollution and pregnancy smoking exposure. Research project had ethical approval from the Ethical Committee, Royal Liverpool Childrens Hospital, Alderhey and Liverpool School of Tropical Medicine and Environment protection department, Sefton Council.

Results: There were significant independent associations of childhood obesity with High NOX-PM10 Emissions + MSDP (AOR 4.47, 95% CI 1.22-16.43, p = 0.024), maternal smoking during pregnancy (AOR 1.84, 95% CI 1.01-3.34,p=0.045) after adjusting for confounding factors. There were significant independent associations of croup with High NOX emissions (AOR 0.43, 95% CI 0.24-0.79, p =0.006), High NOX-PM10 emissions + PSDP (AOR 0.11, 95% CI 0.01-0.84, p=0.034), and High NOX-PM10 emissions + HSDP (AOR 0.15, 95% CI 0.04-0.70, p=0.015) after adjusting for the confounding factors of household smoking during pregnancy, household socio–economic status (upper quartile), High NOX emissions, High NOx + PM10 emissions, High NOX-PM10 emissions + PSDP, High NOX-PM10 emissions + HSDP. There were significant independent associations of increased female births with MSDP (AOR 1.60, 95% CI 0.72-3.53, p = 0.003) and HSDP (AOR 2.20; 95% CI 1.10-4.39, p = 0.025) after adjusting for confounding factors. Venn diagram illustration showed increased overlapping between childhood obesity and maternal smoking during pregnancy compared to the overlap between childhood obesity and high NOx-PM10 emissions + MSDP. The PAR for childhood obesity associated with high NOx-PM10 emissions + MSDP was 44.38%.

Conclusion & Significance: Combined high NOx-PM10 emissions and maternal smoking during pregnancy were associated with an increased risk of childhood obesity. There was a decreased croup with combined exposure to air pollution and paternal smoking during pregnancy, or combined air pollution and household smoking during pregnancy. These cross-sectional studies have identified the role of sequential community surveys of child health and need of air pollution monitoring in this community. Decreasing survey compliance was an increasing problem which will impact on the validity of future surveys.

Recommendations: There is need for better understanding into genetics, toxicology, gene environment interactions as well as mechanisms underlying the associations between air pollution and child-health later in life. Quantitative and qualitative data on dust and other pollutants in the Sefton area will help to determine whether it is particle size or composition that is associated with the respiratory symptoms. Monitoring of children's respiratory health in Merseyside in relation to pollution levels should include conducting repeat cross-sectional questionnaire based surveys of respiratory health in primary school children, in order to assess the trends and to determine whether pollution levels and symptom prevalence are changing.