Exposure to moderate air pollution and associations with lung function at school-age: a birth cohort study

Fabienne Decrue1, Jakob Usemann1, Insa Korten2, Elena Proietti1, Olga Gorlanova1, Danielle Vienneau3, Oliver Fuchs2, Philipp Latzin2, Martin Röösli3 and Urs Frey1 on behalf of the BILD study group

1University Children’s Hospital Basel UKBB, University of Basel; 2Pediatric Respiratory Medicine, Department of Pediatrics, Inselspital, Bern University Hospital, University of Bern; 3Swiss Tropical and Public Health Institute Basel, University of Basel, all Switzerland.

Methods

• In a prospective birth cohort study (Basel and Bern Infant Lung Development [BILD] cohort) of 304 healthy term-born infants, 232 (79%) completed lung function at follow-up at six years.
• Using spatial-temporal models, levels of individual air pollution (nitrogen dioxide [NO2] and ozone [O3], particulate matter with a diameter <10 µm [PM10]) were estimated for the yearly time windows pregnancy, first up to the sixth year of life, and birth until follow-up at age six.
• Time window means were compared to World Health Organization (WHO) guideline limits.
• Associations of exposure windows with spirometry (FEV1, FVC, FEV1/FVC) and body plethysmography (FRCpleth) indices were analyzed using regression models, adjusting for potential confounders.
• For subgroup analysis, patients were categorized into quartiles based on individual pollution levels (four groups of 52 children each).

Results

• Of the 232 children, 44 (19%) were exposed to ETS during the study period, 17 (7%) had asthma at six years, and 89 (38%) had atopic mothers.
• Mean NO2 level from birth until follow-up was (11.8 µg/m³, range 4.9 to 35.9 µg/m³), which is almost 4-times lower than the WHO suggested limit of 40 µg/m³ (Figure 1).
• In the whole population, increased air pollution levels from birth until follow-up were associated with reduced lung function at six years. In the subgroup analysis, the 52 children exposed to NO2 levels from the highest quartile during pregnancy, the first and second year of life and from birth until follow-up, had a significant decrease in FEV1 (Figure 2).
• Per interquartile range increase of NO2, FEV1 decreased by (change in ml [95% confidence interval]) (-171 [-267 to -75]), (-155 [-258 to 53]) and (-136 [-221 to -51]), respectively (Figure 2).

Conclusion

• Our results suggest that exposure to higher NO2 levels, which are still much lower than WHO guideline limits, especially during the sensitive period of early lung development, may be associated with reduced lung function at school-age.
• These findings support the concept of age and dose-dependent pollution effects on lung function in healthy school-aged children and underline the importance of further pollution reduction measures.

Figure 1 Temporal development of mean NO2 (µg/m³) levels for each quartile. Temporal decrease over all investigated time windows (pregnancy, 1st year, 2nd year, 3rd year, 4th year, 5th year, 6th year). The population was divided into quartiles by individual NO2 (µg/m³) levels; per quartile n=52.

Figure 2 Effect of NO2 (µg/m³) levels on FEV1 (ml) at six years. The population was divided into quartiles by individual NO2 levels (per quartile n=52). This resulted in low exposed (1st quartile), mid exposed (2nd and 3rd quartile) and highest exposed (4th quartile) subgroups. NO2 (µg/m³) during different time windows (pregnancy, 1st year, 2nd year, 3rd year, 4th year, 5th year, 6th year) and its effects on FEV1 (ml) at six years of age was calculated for 1st quartile, 2nd and 3rd quartile combined, and 4th quartile.

Funding

• Goldschmidt-Jacobson Foundation
• Swiss National Science Foundation
• Special Program Botnar Foundation

Contact: fabienne.decrue@ukbb.ch