European Respiratory Society
Annual Congress 2012

Abstract Number: 606
Publication Number: 4519

Abstract Group: 6.2. Occupational and Environmental Health
Keyword 1: Air pollution **Keyword 2:** Public health **Keyword 3:** Epidemiology

Title: Outdoor exposure to formaldehyde is associated with increased DNA damage and respiratory symptoms in children

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Body: Background: Exposure to air pollutants emitted by industrial sources may be a health hazard for children living nearby. Objectives: to evaluate whether residential outdoor exposure to formaldehyde was associated with DNA damage and with respiratory symptoms in children who lived in the largest chipboard manufacturing area in Northern Italy (Viadana). Methods: In 2010, randomly selected children (6-12 years) living in the Viadana district were surveyed through a parental questionnaire on respiratory symptoms. A score was devised to evaluate the presence/intensity of asthma-like symptoms. DNA strand breaks and nuclear abnormalities of the oral mucosa cells were analyzed by the comet and micronucleus assays respectively. Passive samplers (n=63) were installed in the area to monitor formaldehyde both in winter and summer 2010. Kriging interpolation was used to estimate the concentration of formaldehyde of each child. Appropriate regression models were fitted to the data. Results: 417 out of 656 eligible children (64%) took part in the study. Children living near (<2km) the chipboard factories had the highest ($p<0.001$) formaldehyde exposure. A 1-standard deviation increase in formaldehyde (+0.16 $\mu g/m^3$) was associated with an increase of 10% (95%CI: 5-20%) in the comet tail intensity and of 10% (95%CI: 1-19%) in the frequency of nuclear buds. Children exposed to the highest level of formaldehyde (>85th centile) had an increased risk of asthma like symptoms (OR=2.1; 1.1-4.2). Conclusions: Exposure to pollutants emitted by chipboard industries statistically significantly increased DNA damage and asthma-like symptoms in children.