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ORIGINAL ARTICLE

Prenatal and postnatal exposure to polycyclic aromatic hydrocarbons and allergy symptoms in city children

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Abstract
Background: Studies indicate that exposure to polycyclic aromatic hydrocarbons (PAH) is associated with adverse respiratory and allergy outcomes. Exposure to PAH may impair the immune function of the foetus and, subsequently, be responsible for an increased susceptibility of children to allergic diseases.
Objectives: The aim of the present study was to assess the association between mother's exposure to PAH during pregnancy and allergy diseases in their infants. We also assessed the above associations using measured PAH exposure in children's urine during the first two years of life.
Methods: The current analysis was restricted to 455 mothers and their children from Lodz district. The women were interviewed three times during the pregnancy in order to collect demographic, socio-economic and medical history data. Children's health status was assessed at the age of 10–18 months and repeated at two years of age. The associations between dependent dichotomous variables and urine concentrations of 1-hydroxypyrene (1-HP) were analysed using logistic regression.
Results: We showed that higher urine concentrations of 1-HP in mothers at 20–24 weeks of pregnancy increased the risk of more frequent respiratory infections ($p = 0.02$) in children during their first year of life. Higher 1-HP concentrations in children's urine increased the risk of food allergy ($p = 0.002$) in children during their first two years of life.
Conclusions: This study suggests awareness of environmental factors, which may affect children's health since PAH showed to be a risk factor for airway infections and food allergy in children after adjustment for other risk factors.

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Introduction

Polycyclic aromatic hydrocarbons (PAH) are a well-known class of environmental pollutants that usually occur as complex mixtures of more than 300 compounds composed of fused aromatic rings. The source of PAH includes emissions from car fumes, coal-fired power plants, residential heating (e.g. coal or wood stoves, fireplaces) unvented gas appliances, environmental tobacco smoke and domestic cooking procedures such as grilling and roasting.

Exposure to PAH may impair the immune function of the foetus and, subsequently, be responsible for an increased susceptibility of children to respiratory diseases.[1–3] For some symptoms the effect of PAH exposure is partly modified by exposure to environmental tobacco smoke (ETS). The study by Miller et al. has shown that prenatal PAH exposure in the presence of postnatal ETS exposure was associated with increased cough and wheeze at 12 months of age and breathing problems and reports of probable asthma at two years of age.[1] Another study has shown an increased risk of various respiratory symptoms (including barking cough, wheezing, sore throat) and ear infections associated with PAH exposure. In addition, in this study the impact of PAH exposure on duration of respiratory symptoms has been observed.[2] It has also been demonstrated that combined prenatal exposure to PAH and ETS was associated with asthma but not atopy at age 5–6.[3] It is important to remember that many PAH are powerful carcinogens and that prenatal exposure to many air pollutants besides PAH is linked to allergic diseases in children such as asthma.[4,5]

The measurement of urinary PAH metabolites provides a valuable tool to assess the individual level of internal PAH exposure.[6,7]

Levels of 1-hydroxypyrene (1-HP) – the main pyrene metabolite, have been used as representative indicators of PAH exposure. Our previous analysis based on Polish Mother and Child Cohort (REPRO_PL) indicated that non-smoking pregnant women suffer from a higher PAH exposure (based on nine PAH metabolites) than those from other western countries.[8] 1-HP was highly correlated with other PAH metabolites.

In our previous report, associations between different factors affecting pregnant women and young children and children's health status were found.[9–12] In the present study, we hypothesised that maternal prenatal urine metabolite concentration of PAH would be associated with wheezing, food allergy, early eczema and infections among city children. The aim of the present study was to assess the association between mother's exposure to PAH during pregnancy and respiratory infections and allergic diseases in their infants. We also assessed the above associations using measured PAH exposure in children's urine during the first two years of life.

Materials and methods

Study area

Lodz voivodeship (highest-level administrative subdivision of Poland corresponding to a district or province) is situated in Central Poland. At the end of 2013 Lodz voivodeship had a population of 2,607,380 with 622,290 inhabitants below 19 years (<5 years: 139,613; 6–13 years: 246,861; 14–19 years: 235,816). Lodz district is the centre of the textile and chemical industry with many power stations. Air dust pollution in Lodz district is one of the highest in Poland. In 2013 mean dust concentration in the city centre of Lodz was 38 mcg/m^2 and emission of sulphur dioxide per 1 km^2 in total was 23.1.[13] Data presented by the WHO indicate that cities and towns in Poland are the most polluted in the EU (based on the annual average PM2.5 level mcg/m^3; https://www.reddit.com/r/europe/comments/4j82zs/most_polluted_cities_and_towns_in_the_eu/?). Of 154 cities in Poland, Lodz was located on the 69th position of the highest PM2.5 levels (with the annual PM2.5 level in 2013 equal 27 mcg/m^3; comparing to the highest 43 mcg/m^3 in Zywiec and the lowest 8 mcg/m^3 in Inowroclaw) (http://www.who.int/phe/health_topics/outdoorair/databases/cities/en/). Our previous analysis performed on the population of pregnant women from Lodz district has also confirmed high levels of PAH metabolites.[8]

There are some major sources of PAH in Lodz district such as: industry, motor vehicles and trucks, coal burning, and burning of biomass such as trash. However, there is limited data on airborne levels of PAH in the Lodz district. The epidemiological situation in the city centre of Lodz is far worse with a percentage of adult asthma of 13.2 and children asthma of 18.4.[14,15]

Study design and population

The present study was based on the data from the Polish Mother and Child Cohort (REPRO_PL) – a multicentre prospective cohort study established in 2007.[9–12] The mothers' recruitment and follow-up procedures and complete description of the methodological assumptions has been published elsewhere.[16,17] The women were recruited from the general population during the first trimester of pregnancy at maternity units or clinics if they fulfilled the following inclusion criteria: single pregnancy up to 12 weeks of gestation, no assisted conception, no pregnancy complications (including possible spontaneous abortion or child malformations), and no chronic diseases as specified in the study protocol (including pre-pregnancy diabetes, hypertension, cancer, heart diseases).[16] Maternal asthma and allergy did not constitute an exclusion criterion for the study. The current analysis was restricted to 455 mothers and their children from Lodz district.

The study was approved by the Ethical Committee of the Nofer Institute of Occupational Medicine, Łódź, Poland (Decision Nos. 7/2007 and 3/2008) and a written consent was obtained from all the subjects (pregnant women and patents of the children) before the study.

Mother health assessment

The women were interviewed three times during the pregnancy (once in each trimester) in order to collect and update demographic and socio-economic data, medical and reproductive history, and information about environmental and occupational exposures.