

# Lung hyperpermeability and asthma prevalence in schoolchildren: unexpected associations with the attendance of indoor chlorinated swimming pools

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## Introduction

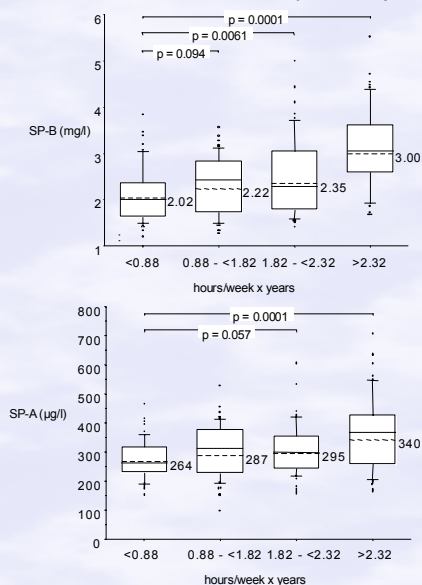
- For several decades, chlorination has been used to destroy microbiological pathogens and organic matter in swimming pools.
- When reacting with organic matter brought by swimmers (e.g. urine, sweat), hypochlorous acid generates a complex mixture of potentially harmful disinfection by-products from which the most volatile and also most concentrated in the air of indoor pools is nitrogen trichloride (NCl<sub>3</sub>), a powerful irritant.

The aim of this study was to investigate whether exposure to nitrogen trichloride in indoor chlorinated pools may affect the respiratory epithelium of children and increase the risk of some lung diseases such as asthma.

## Observations

### 1. Chronic effects of air pollution on the respiratory epithelium:

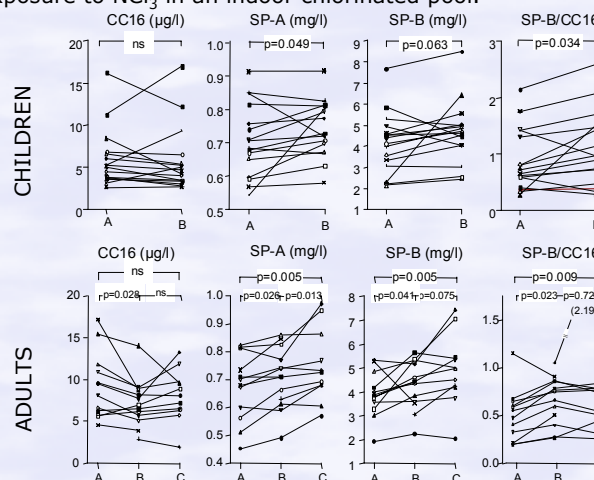
- 226 healthy children aged 8-12 years were recruited from seven primary schools, two in Brussels and five in a rural area (Ardenne).
- The cumulated pool attendance of these children ranged from less than 0.55 to 6.42 hours/week x years.
- The integrity of lung epithelium was assessed by measuring three lung specific proteins in serum: the surfactant-associated proteins A and B (SP-A and SP-B) and the 16 kDa Clara cell protein (CC16).



A positive dose-effect relationship was found with cumulated pool attendance and serum SP-A and SP-B. No clear dose-effect relationship was found for serum CC16 (ANOVA,  $p = 0.07$ ).

### 2. Acute effects of air pollution on the respiratory epithelium:

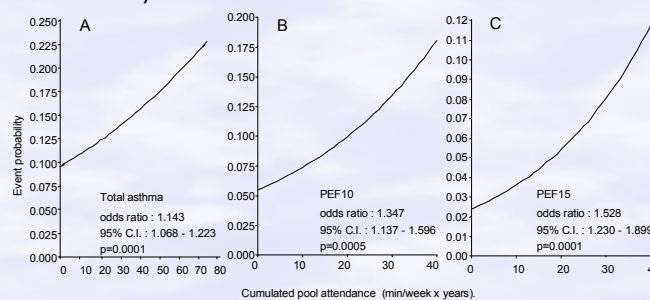
- Lung specific proteins were measured in the serum of 16 children and 13 adults both before and after a 1- to 2-hour exposure to NCl<sub>3</sub> in an indoor chlorinated pool.



These changes in serum levels of lung proteins were reproduced in children and adults attending an indoor pool with a mean NCl<sub>3</sub> concentration of 0.490 mg/m<sup>3</sup>. Serum SP-A and SP-B were already significantly increased after one hour by the pool side without swimming.

### 3. Relationships between pool attendance and asthma prevalence:

- 1,881 children (15 Brussels primary schools) aged 6-14 years: cumulated pool attendance of 0.7 to 2.5 hours/week x years.
- Screening for asthma: a child was considered EIB-positive (exercise-induced bronchoconstriction test) when his PEF (peak expiratory flow) dropped by 10 % or more (PEF10) or 15 % or more (PEF15) at 5 or 10 min after a 6 minute-runabout indoors.
- Total asthma prevalence was calculated as the sum of the prevalence of PEF10 plus the prevalence of EIB-negative children actually treated for asthma.



PEF10, PEF15 and total asthma prevalences were significantly correlated with cumulated pool attendance indices.

## Conclusions

Regular attendance of chlorinated pools by young children is associated with an exposure-dependent increase in lung epithelium permeability and an increase in the risk of developing asthma, especially in association with other risks factors such as exposure to pets. These findings lead us to postulate that the increasing exposure of children to chlorination products in indoor pools might be an important cause of the rising incidence of childhood asthma and allergic diseases in industrialized countries. Further epidemiological studies should be undertaken to test this hypothesis.

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