

Epidemiology of pollution-induced airway disease: urban/rural differences in East and West Germany

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The prevalence of asthma and allergic disorders was assessed in 9–11 year-old children in Leipzig and Halle in East Germany, as well as in Munich, West Germany. Both East German cities are heavily polluted due to private burning of coal and industrial emissions, while Munich has low smoke emissions but heavy road traffic. All fourth grade pupils in Munich were compared with those in Leipzig and Halle. Non-specific airway disease (bronchitis), cough, and autumn/winter nasal symptoms were most prevalent in Leipzig and Halle. Hay fever and skin test reactivity to aeroallergens were higher in West Germany compared with East Germany. Furthermore, the prevalence of asthma was also higher in the West German study area. Increased skin prick test reactivity in the West explained the increased prevalence of asthma. Longitudinal analysis showed increased respiratory symptoms on days with high mean levels of sulphur dioxide and oxides of nitrogen, as well as on days with a high peak level of 10 μ respirable particles (PM10) in East Germany. The effects of these pollutants were additive. Exposure to heavy road traffic in Munich was related to decreased pulmonary function and non-specific airway symptoms, but not to allergic sensitization and asthma.

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Introduction

Allergic diseases tend to run in families and therefore have a strong genetic component (1). Although concordance for atopy is higher between monozygotic twins than between dizygotic twins, it is lower than that observed in other genetically determined illnesses (2). Environmental factors must therefore play a major role in the development of allergic symptoms, and airborne pollutants are obvious candidates. Many studies have reported an increase in allergic diseases, particularly in children, which has led to increasing interest in elucidating the possible causal relationship.

Outdoor air pollutants, such as sulphur dioxide (SO₂), 10 μ particulate respirable particles (PM10), automobile emissions, and ozone, have been proposed as potential risk factors for asthma and allergic disorders (3, 4), but this has not been confirmed in all studies. It is often impossible to distinguish between the effects of environmental exposure to such pollutants and genetic differences between exposed or non-exposed populations.

Furthermore, individuals are rarely exposed to only one pollutant, and it is therefore difficult to measure their effects in isolation. Mobility within populations will also obscure any potential effects.

The unification of Germany provided a unique opportunity to study the impact of exposure to different environmental pollutants on the development of allergies in two genetically homogenous populations. For 45 years, there was almost no population exchange between East and West Germany. Greater car ownership and nitrogen dioxide (NO₂) exposure was characteristic of West German cities, while industrial emissions and pollution from domestic brown coal burning was more typical in East German cities.

The prevalence of asthma and allergic disorders was compared among children living in East and West Germany shortly after the destruction of the Berlin wall. If differences in environmental conditions are indeed important, significant differences in the prevalence of allergic sensitization and allergic diseases should be evident between the East and West regions.

Methods

Asthma and allergic disorders were assessed in 9–11 year-old children in Leipzig and Halle in East Germany, as well as in Munich in West Germany. The East German cities are heavily polluted due to brown coal burning for domestic heating, and industrial emissions, whereas Munich has almost no high smoke emissions but does have heavy road traffic. Fourth grade pupils ($n=7,445$) attending all primary schools in Munich were included in a first study in 1989–1990, and school children ($n=3,105$) attending fourth grade classes in a random sample of 39 schools in Leipzig and 23 schools in Halle were studied in East Germany in 1991–1992.

An identical, self-administered questionnaire was distributed to the parents of the children in all study areas. The questionnaire focused on sociodemographic characteristics, physician's diagnoses, and typical symptoms of respiratory and allergic disorders, and their possible aetiological factors. Atopic sensitization was assessed by skin prick tests to six common aeroallergens (*Dermatophagoides pteronyssinus*, mixed grasses, birch and hazel pollen, cat and dog dander). Bronchial hyperresponsiveness (BHR) was assessed by cold air hyperventilation challenge.

Also, in a time series analysis, respiratory symptoms were related to daily measurements (mean and peak) of SO_2 , NO_2 , and PM_{10} in East Germany during the year of study, and data were analyzed separately for the summer and winter seasons.

In Munich, road traffic volume in the busiest street of the school precinct of each child was related to respiratory symptoms, allergy test results, and lung function tests, in a multivariate model including other known risk factors for asthma.

Results

The prevalence of physician-diagnosed hay fever was significantly lower in Leipzig than in Munich. Parents were also asked to indicate whether symptoms occurred predominantly during specific months. In Munich, rhinitis symptoms showed a strong peak during the summer months, when pollen counts are high, whereas in Leipzig, the reported frequency of these symptoms increased only slightly during the summer and also increased during the winter months.

Lifetime prevalence of physician-diagnosed asthma was higher in West Germany than in East Germany. The lifetime prevalence of recurrent wheezing, nocturnal cough, and frequent cough with exercise or during foggy or cold weather, however, was higher in East Germany.

A significantly increased frequency of atopic sensitization to mites, pollen, and cat dander, as assessed by skin prick tests, was found in children in West Germany, whereas children in both parts of the country reacted with similar frequency to dog dander. The prevalence of BHR was significantly higher in West Germany compared with the eastern part of the country (5).

The association of asthma and bronchitis to skin test reactivity, BHR, and study area was further assessed in a multivariate logistic regression analysis (5). As a first step, age, gender, and the study area were entered into the model. The West German area was a significant risk factor for the development of asthma whereas the East German study area was significantly associated with a diagnosis of bronchitis. After introducing sensitization to mites, pollen, cats or dogs into the model, the West German area was no longer significantly associated with a higher prevalence of asthma. However, East Germany remained a highly significant risk factor for the development of bronchitis. BHR was a strong risk factor for asthma, but not for bronchitis, in both areas.

In both East and West Germany, the prevalence of atopic sensitization decreased significantly with increasing numbers of siblings (6). This relationship remained significant when controlling for family history of asthma or atopy, gender, education, smoking, pet ownership, the age of the subject, the month of testing, and the study area.

In East Germany, high daily mean SO_2 and oxides of nitrogen (NO_x) levels, and high peak values of PM_{10} , were associated with increased non-specific upper respiratory tract symptoms, and the effects of these pollutants were additive (7).

High volume of road traffic was associated with impaired pulmonary function and increased respiratory symptoms in children in Munich (8). However, the prevalence of allergic rhinitis and asthma was not associated with increasing volume of traffic. The decrease in peak respiratory flow rates was comparable with the effect of passive smoke exposure in the same population (9).

Discussion

The prevalence of hay fever and skin test reactivity to common aeroallergens was found to be considerably higher in West Germany than in East Germany. Furthermore, the prevalence of asthma was also higher in the West German study area (5, 10), a finding confirmed by other studies (11). However, when atopy was taken into consideration, there was no longer a significant difference in the prevalence of asthma between East and West Germany. Outdoor air pollution (high daily mean

NO_x and SO₂, and peak PM₁₀) was associated with non-specific respiratory symptoms in the East (acute effects) (7). Increasing exposure to road traffic was associated with diminished lung function and an increased prevalence of non-specific respiratory symptoms, but not of asthma and allergic rhinitis (8) or skin test positivity (chronic effects).

In West Germany, atopic sensitization to aeroallergens was 2.5–3 times higher when compared with East Germany. Other authors (12) found more children in the East (Halle) to have dust mite or pollen-specific immunoglobulin E than in the West (Cologne and Düsseldorf).

The reasons for the higher prevalence of atopic sensitization in West Germany are not known. Our results suggest that air pollution by SO₂, particulate matter, and car emissions (5, 10) is not a strong risk factor for atopy. Measurements of house dust mite allergy (Der pI and Der fI) in dust from East and West German homes, however, suggest a higher mite exposure in Eastern dwellings (13). However, sensitization to house dust mite was less frequent in East German than in West German children. Similar findings are reported from other surveys in cities (12, 14): 6.8% of the children in Halle compared with 13.7% in Cologne and 13.2% in Düsseldorf were radioallergosorbent test (RAST)-positive for house dust mite. A recently published survey of adults in Hamburg (West Germany) and Erfurt (East Germany) found increased respiratory symptoms, bronchial hyperreactivity, and skin prick test reactions, as well as specific IgE antibodies to inhalant allergens (including house dust mite and pollen) (15). Other studies found increased RAST-test positivity in urban regions of West Germany (11) and Austria (16) compared with rural areas of the respective countries.

Day-care settings were attended by approximately 70% of children aged 1–3 years in East Germany, whereas only around 8% of children in this age group had access to day care in West Germany (5). Moreover, in our study, children from East Germany had significantly more siblings than those from West Germany (5). This suggests that factors such as those proposed by Strachan (17) could play a role in the differences observed in the prevalence of atopic sensitization between West and East Germany. Nonetheless, even when this effect was included in a multiple logistic regression model, the differences in allergic sensitization between East and West Germany were barely changed.

The prevalence of bronchitis, wheezing, and cough was greater in East Germany than in the western part of the country. This is in agreement with findings reported by Krämer *et al.* (11) com-

paring 6-year old children in Halle and Leipzig in East Germany, with those in Duisburg and Düsseldorf in West Germany. The reasons for this increase remain to be elucidated. Since atopy and BHR are not significantly related to bronchitis in East Germany, factors other than asthma may be important. Leipzig and Halle are heavily polluted by SO₂ and particulate matter. An increased prevalence of cough has been observed among children intermittently exposed to very high concentrations of SO₂ at moderate levels of particulate SO₄ (18). The American Six Cities Study reported a positive correlation for the prevalence of bronchitis and chronic cough with exposure to particulate matter (3). However, no association between the prevalence of persistent wheeze or asthma and exposure to particulate matter, NO₂, or SO₂ was observed. Our findings of an increased prevalence of bronchitis and frequent cough in Leipzig, with levels of SO₂ and particulate matter higher than in Munich, thus confirm earlier reports of this association, although it does not allow assessment of the individual effect of each factor. The time series analysis showed that short-term exposure to NO_x, SO₂, and PM₁₀ is associated with non-specific symptoms of the upper respiratory tract (7).

The higher prevalence of asthma and BHR in response to cold air challenge in West Germany compared with East Germany provides evidence that long-term exposure to SO₂ (even at the observed very high levels) and particulate matter does not primarily affect BHR and asthma.

Conclusion

Our results suggest that the difference in the prevalence of asthma between West and East Germany is attributable to a difference in the prevalence of atopic sensitization between the two parts of the country. Both study populations comprised German children sharing a homogenous genetic background. Therefore, differences in the prevalence of diseases between both areas of Germany reflect environmental influences. Exposure to outdoor air pollution in the form of SO₂, particulate matter, and vehicle exhaust emissions, was associated with bronchitis, non-specific respiratory symptoms, and decrements in pulmonary function, but not with asthma and atopy.

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