

## Trends in prevalence of atopic diseases and allergic sensitization in children in Eastern Germany

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**ABSTRACT:** Trends in prevalence of atopic diseases and allergic sensitization in children from Eastern Germany during the 1990s were analysed.

The study consisted of three regional cross-sectional surveys of a total of 7,632 children (aged 5–14 yrs) in 1992–1993, 1995–1996, and 1998–1999. Information was gathered on atopic diseases and potential predictors by a parental questionnaire. Allergic sensitization for birch, grass, mite, cat, and cladosporium were assessed by radioallergosorbent test (RAST).

After adjustment for age, sex and the study area of the participants, prevalence increased between the first and third survey for hay fever, for asthma and for atopic eczema. The adjusted prevalence of allergic sensitization ( $\text{RAST} > 0.35 \text{ kU}\cdot\text{L}^{-1}$ ) showed a decrease, whereas the prevalence of strong sensitization ( $\text{RAST} \geq 17.5 \text{ kU}\cdot\text{L}^{-1}$ ) increased significantly, specifically in cohorts born after 1989. Further adjustment for possible determinants of these atopic diseases did not change the trend estimates.

A clear increase in the prevalence of atopic diseases, with the exception of hay fever, was observed as well as a shift towards a stronger allergic sensitization, which might affect the onset of clinical manifestations of atopic diseases.

Differences in the epidemiology of respiratory symptoms, illnesses and allergies between populations living in the former East Germany and those living in the former West Germany have been reported. Among East German children, lower prevalence rates of asthma, and positive skin-prick tests were observed compared to West German children in the early 1990s [1–5]. Similarly, among East German adults, lower specific immunoglobulin (Ig) E levels and lower prevalence rates of asthma, wheezing, positive methacholine-challenge tests, allergic rhinitis, and positive skin-prick tests have been reported compared to those of West German adults [6, 7].

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The prevalence of allergies was similar between East and West Germans born before ~1960. Among adults born after 1960, allergies were more prevalent in West compared with East Germany [7, 8]. It has been hypothesized, that since the 1960s, there have been factors present in the West but not in the East which were related to the higher prevalence of allergies among West-German populations [7–9]. After German reunification in 1990, the East-German population rapidly adopted a modern "Western lifestyle" [5, 9]. Some of the adopted "Western-lifestyle" factors that may have affected the development of allergies included fewer homes heated with coal or wood [2, 10], better house insulation and tighter windows with a subsequent increase in dampness and moulds [2, 10], more cars (Kraftfahrtbundesamt, Flensburg, Germany, personal communication), "Western" food such as exotic fruits and vegetables [11], and fewer infectious diseases including helminthic infections during early childhood [12].

If these environmental and lifestyle factors contributed to the higher prevalence of allergies among

West Germans, an increase in the prevalence of allergies among East Germans after reunification would be expected. However, it is unknown if this really occurs and whether it is restricted to persons born after the adoption of these Western-like conditions because of the importance of early childhood in the development of allergies.

A possible increase in the prevalence of allergic diseases, symptoms, sensitization, and asthma was analysed using a data set including children who were born after German unification in 1990.

### Methods

#### Design

The study consisted of three consecutive regional cross-sectional surveys of children aged 5–14 yrs in 1992–1993, 1995–1996 and 1998–1999. Three study areas differing in air pollution levels were selected. The study included three embedded cohorts, therefore

children participated in two or three surveys. Data concerning the long-term effects of air pollution on respiratory health in East German children (Bitterfeld Study) [13, 14] was gathered. The data collection and methods have been described in detail in previous studies [13, 14].

#### *Study area and sources of air pollution*

The study was conducted in the counties of Bitterfeld, Hettstedt and Zerbst in the State of Sachsen-Anhalt (formerly German Democratic Republic). The three study areas are located in a circle of 100 km in diameter and share similar meteorological conditions. In the past, the three study areas strongly differed in levels of "classical" air pollutants such as total suspended particulates (TSP) and sulphur dioxide (SO<sub>2</sub>).

After German reunification, the amounts of SO<sub>2</sub> and TSP emissions decreased greatly, especially during the years 1990 and 1991. The closure of most industrial plants and the replacement of surface coal by natural gas for domestic heating contributed to the decrease in SO<sub>2</sub> and TSP. More detailed descriptions of the study areas have been published previously [13–15].

#### *Subjects*

All first-, third-, and sixth-grade school children who were residents of Zerbst and Hettstedt counties and a subgroup of children from selected schools in Bitterfeld County were invited to participate in this study. All day-care centres and schools in the Zerbst and Hettstedt areas were contacted. Because of the larger area of Bitterfeld county, schools and day-care centres in this county were randomly selected to represent all resident school-aged children. Children were excluded from analysis if they had lived for <2 yrs in their current home and their previous home was located >2 km away from their current home. The population in all three areas was very homogeneous and all participants were White. Mentally- or physically-handicapped children who attended specialized institutions were not included in this study. The University of Rostock Ethics Committee approved the study protocol. Informed consent was obtained from the parents of all participating children.

#### *Respiratory disorders*

As part of the study, teachers distributed questionnaires to the childrens' parents and collected completed questionnaires a week later. The questionnaire contained 78 items that have been described previously [13, 14]. The following health outcomes were analysed in the study: a parental report of a physician's diagnoses (lifetime) of hay fever, asthma, and eczema, as well as parent-reported allergic symptoms such as reddened eyes, sneezing attacks, runny or blocked noses, and itchy rashes.

#### *Assessment of allergic sensitization by immunoglobulin-E measurement*

Blood collection, centrifugation and serum storage methods have been described in detail in a previous study [13]. The serum samples of the first and second survey were stored at -20°C until the end of the second survey when they were analysed by the CAP-FEIA method using identical batches of reagents for all assay runs for specific IgE to *Dermatophagoides pteronyssinus* (d1), *cladosporium* (m2), cat (e1), mixed grasses (g6), and birch (t3). The serum samples of the third sample were also stored at -20°C until analyses for specific IgE. All measurements were conducted in one laboratory (Pharmacia Diagnostics, Freiburg, Germany). The intra- and inter-assay coefficients of variation were 7% (Pharmacia, Freiburg, Germany personal communication). The measurement range was 0.35–100 kU·L<sup>-1</sup> with a detection limit >0.35 kU·L<sup>-1</sup>. Standard curves were set up in duplicate and the samples were assayed in single determinations.

#### *Statistical methods*

Crude prevalence rates for all binary outcome variables were calculated for the participating children in the surveys. Multiple logistic regression analyses were used to adjust the estimates of the temporal changes (second *versus* first survey and third *versus* first survey) of the prevalence of physician-diagnosed atopic diseases, allergic symptoms, and sensitization assessed by RAST for covariates or potential confounders. Only children with complete information regarding all covariates were included in the analyses. The results are presented as adjusted odds ratios (OR) with 95% confidence intervals (CI). Repeated measurements in some of the children were accounted for.

## **Results**

#### *Participation rates and demography*

In total, parents of 7,632 of 9,630 eligible children aged between 5–14 yrs completed a questionnaire (table 1). The response rates differed slightly between study areas and surveys and ranged between 68.6–92.1% (table 1). Data for a total of 6,959 questionnaires (4,949 children) contributed to the descriptive analyses, where 3,264 children participated in one survey, 1,360 children in two surveys, and 325 children in all three consecutive surveys. Children from the first of the three surveys were quite comparable with regard to sex and parental education to those participating in the other surveys, but children who participated in the first survey were slightly younger (table 1). Changes in the age distribution of the study populations between the first and the other surveys were caused by a general decrease in birth rates after German reunification (which fell by as much as 60%) in Eastern Germany from 1990–1991 [16].

Table 1.—Response, mobility, and characteristics of the study population of surveys 1 (1992–93), 2 (1995–96) and 3 (1998–99)

	Survey 1	Survey 2	Survey 3
Responders (questionnaire)			
Total	2470/2773 (89.1)	2814/3765 (74.7)	2348/3092 (75.9)
Zerbst	857/971 (88.3)	748/1090 (68.6)	695/989 (70.3)
Bitterfeld	799/918 (87.0)	1255/1561 (80.4)	961/1203 (79.9)
Hettstedt	814/884 (92.1)	811/1114 (72.8)	692/900 (76.9)
Considered in analyses			
Total	2335/2773 (84.2)	2517/3765 (66.9)	2107/3092 (68.1)
Zerbst	818/971 (84.2)	674/1090 (61.8)	631/989 (63.8)
Bitterfeld	737/918 (80.3)	1108/1561 (71.0)	849/1203 (70.6)
Hettstedt	780/884 (88.2)	735/1114 (66.0)	627/900 (69.7)
Demographic characteristics			
Age			
5–7 yrs	726/2335 (31.1)	642/2517 (25.5)	325/2107 (15.4)
8–10 yrs	750/2335 (32.1)	855/2517 (34.0)	757/2107 (35.9)
11–14 yrs	859/2335 (36.8)	1020/2517 (40.5)	1025/2107 (48.6)
Males	1184/2335 (50.7)	1354/2517 (53.8)	1144/2107 (54.3)
Higher parental education <sup>#</sup>	958/2272 (42.2)	1010/2398 (42.1)	812/2023 (40.1)
Other characteristics (predictors for adjustment)			
Low birth weight <sup>†</sup>	146/2240 (6.5)	141/2373 (5.9)	125/1881 (6.6)
No breastfeeding <sup>‡</sup>	471/2321 (20.3)	460/2498 (18.4)	399/2004 (19.9)
Parental atopy	620/2335 (26.6)	770/2517 (30.6)	647/2031 (31.9)
House made of concrete	901/2245 (40.1)	950/2447 (38.8)	629/1929 (32.6)
Child shares bedroom	1121/2297 (48.8)	1028/2511 (40.9)	665/2021 (32.9)
Dampness or visible moulds	438/2312 (18.9)	568/2506 (22.7)	466/1998 (23.3)
Heating with single oven	1150/2328 (49.4)	931/2421 (38.5)	751/1994 (37.7)
Carpet in child's room	2173/2329 (93.3)	2026/2479 (81.7)	1845/2008 (91.9)
ETS exposure <sup>§</sup>	1076/2305 (46.7)	1074/2489 (43.1)	915/2084 (43.9)
Contact to cats	750/2300 (32.6)	815/2510 (32.5)	722/2000 (36.1)
Child attended day-care centre <sup>f</sup>	2062/2314 (89.1)	2218/2499 (88.8)	1764/2061 (85.6)

Data are presented as respondents/total with % in parentheses. ETS: environmental tobacco smoke. <sup>#</sup>: education of father or mother  $\geq 12$  yr; <sup>†</sup>:  $\leq 2700$  g; <sup>‡</sup>:  $< 4$  weeks; <sup>§</sup>: current or prior; <sup>f</sup>: before 1 yr of age.

#### Temporal changes of respiratory disorders, demographic characteristics and potential predictors

Temporal changes of characteristics used for adjustment of atopic outcomes are shown in table 1. Crude prevalence of atopic diseases, allergic symptoms and RAST sensitization in the three surveys are shown in table 2. For nearly all atopic diagnoses, a continuous increase of prevalence was found between the three surveys. Regarding allergic symptoms for itchy rash only, an increasing trend of crude prevalence was found. A similar trend was seen for strong allergic sensitization (RAST  $\geq 17.5$  kU·L<sup>-1</sup>), while no clear tendencies were shown for the prevalence of detectable specific IgE antibodies (RAST  $> 0.35$  kU·L<sup>-1</sup>). However, the age distributions shifted towards higher ages (table 1) and affected the crude prevalence estimates.

After adjustment for age, sex and study area, increases in prevalence were found for hay fever, asthma and atopic eczema comparing the third and the second survey with the first survey (fig. 1). The prevalence of allergic sensitization (any specific IgE  $> 0.35$  kU·L<sup>-1</sup>) adjusted for area, sex, and age showed statistically significant decreases for the comparison for the third and the second with the first survey. Prevalence of strong sensitization to any allergens (RAST  $\geq 17.5$  kU·L<sup>-1</sup>) showed statistically significant increases (p-trend 0.021, OR third *versus* first survey

1.33 (1.05–1.67)), OR second *versus* first survey 1.28 (1.05–1.56)) (fig. 1).

Further adjustment for parental education, parental atopy, housing conditions such as dampness, exposure to emissions from gas cooking and environmental tobacco smoke, crowding, carpeting, day-care attendance, contact with cats, breast feeding, low birth weight, and season of examination (only for RAST) did not change the OR (data not shown). Obviously, all these potential influencing factors which are known to have partly changed over time (table 1) contribute slightly to the increase of prevalence of atopic diseases and strong allergic sensitization (RAST  $\geq 17.5$  kU·L<sup>-1</sup>).

A higher prevalence of allergic sensitization, with increasing cut-off points for any specific antibodies during 1992–1999, was found (fig. 1). This pattern was mainly caused by the statistically significant increasing prevalence of specific sensitization to birch pollen and mites (fig. 2)

Age-related effects on the prevalence of atopic outcomes were distinguished from birth-cohort related effects (table 3). The adjusted prevalence of asthma increased continuously in all age groups and even within the three birth cohort subgroups that were born before 1990, the year of German reunification. The adjusted prevalence of hay fever was only marginally increased. A remarkable increase in the

Table 2. – Crude prevalence of atopic diagnoses and symptoms and radioallergosorbent test (RAST)-sensitization in Eastern German children aged 5–14 yrs in Surveys 1 (1992–93), 2 (1995–96) and 3 (1998–99)

	Survey 1	Survey 2	Survey 3
Physician's diagnoses <sup>#</sup>			
Hay fever	102/2327 (4.4)	129/2517 (5.1)	129/2103 (6.1)
Asthma	61/2319 (2.6)	88/2517 (3.5)	98/2062 (4.8)
Eczema	239/2327 (10.3)	259/2517 (10.3)	241/2103 (11.5)
Any allergy against:	316/2312 (13.7)	490/2502 (19.6)	505/2076 (24.3)
Food	39/2305 (1.7)	60/2498 (2.4)	72/2062 (3.5)
Drug	53/2305 (2.3)	39/2498 (1.6)	47/2062 (2.3)
Pollen	106/2305 (4.6)	242/2498 (9.7)	230/2062 (11.2)
Animal dander	48/2305 (2.1)	152/2498 (6.1)	152/2062 (7.4)
Fungi	10/2305 (0.4)	66/2498 (2.6)	68/2062 (3.3)
Allergy symptoms <sup>†</sup>			
Conjunctivitis <sup>#</sup>	153/2302 (6.7)	189/2513 (7.5)	125/2076 (6.0)
Sneezing <sup>#</sup>	193/2302 (8.4)	251/2513 (10.0)	176/2076 (8.5)
Runny nose <sup>#</sup>	201/2302 (8.7)	234/2513 (9.3)	165/2076 (8.0)
Itchy rash <sup>+</sup>	342/2312 (14.8)	449/2509 (17.9)	395/2055 (19.2)
RAST class >0 (0.35 kU·L <sup>-1</sup> )			
Dust mite	303/2016 (15.0)	327/2106 (15.5)	320/1730 (18.5)
Cat	141/1977 (7.1)	152/2106 (7.2)	149/1729 (8.6)
Cladosporium	82/1721 (4.8)	87/2104 (4.1)	71/1728 (4.1)
Birch pollen	186/1702 (10.9)	244/2098 (11.6)	204/1728 (11.8)
Grass pollen	470/1979 (23.7)	393/2104 (18.7)	341/1729 (19.7)
RAST class >3 (17.5 kU·L <sup>-1</sup> )			
Dust mite	44/2016 (2.2)	75/2106 (3.6)	86/1730 (5.0)
Cat	17/1977 (0.9)	23/2106 (1.1)	16/1729 (0.9)
Cladosporium	12/1721 (0.7)	14/2104 (0.7)	4/1728 (0.2)
Birch pollen	21/1702 (1.2)	50/2098 (2.4)	48/1728 (2.8)
Grass pollen	116/1979 (5.9)	110/2104 (5.2)	95/1729 (5.5)

Data are presented as respondents/total with % in parentheses. <sup>#</sup>: last year; <sup>†</sup>: as reported by parents; <sup>+</sup>: lifetime.

adjusted prevalence of atopic eczema was found for children born after German reunification. The latter finding correlates well with the increased prevalence of strong allergic sensitization in these specific birth cohorts (table 3). The increase of prevalence of strong allergic sensitization was found in the two cohorts born in 1990 and 1993, whereas only a marginal increase was found in the cohorts born before 1990. The strongest increase of prevalence of allergic sensitization was seen in children aged 6 yrs who were born in the years 1990 and 1995 (table 3). However, the prevalence of detectable specific IgE did not increase with increasing year of birth (data not shown).

## Discussion

### Summary

In summary, an increase in the adjusted prevalence of asthma and atopic eczema and a marginally significant increase in hay fever was found. A shift towards higher prevalence of a stronger sensitization was observed, however, the prevalence of allergic sensitization to any of the most common aeroallergens showed a marginally decreasing trend. The adjusted prevalence of any strong allergic sensitization (RAST  $\geq 17.5$  kU·L<sup>-1</sup>) increased statistically significantly in parallel with strong allergic sensitization to mite and birch pollen. Children who were born after German reunification showed an increased prevalence for

strong allergic sensitization and atopic eczema, whereas the prevalence for asthma was found to be increased over all birth cohorts.

### Comparison with other studies

Three large studies have been specifically designed to study temporal changes of allergic respiratory health in East German children (table 4). The results of these three studies consistently showed increasing prevalence for hay fever, atopic eczema and asthma, although not for asthma in the Leipzig study [19–21]. The increasing prevalence of asthma was supported by findings of the Bitterfeld Study [22], which found an increasing prevalence of bronchial hyperresponsiveness (BHR). Despite a certain heterogeneity of the results on temporal changes of allergic sensitization (table 4), the two studies showed consistently an increase in prevalence of allergic sensitization to birch pollen and house dust mites, whereas no [17, 18] or even decreasing [22] tendencies were reported for grass pollen. Furthermore, both studies found a consistent increase of prevalence of strong allergic sensitization. One might speculate that the shift to strong allergic sensitization might cause a decreased prevalence of mild sensitization if the population at risk is more or less stable.

There are a number of speculations for the apparent discrepancy in findings between the three studies. Firstly, the studies differed in the degree of urbanization as a result of a more rapid westernization in the

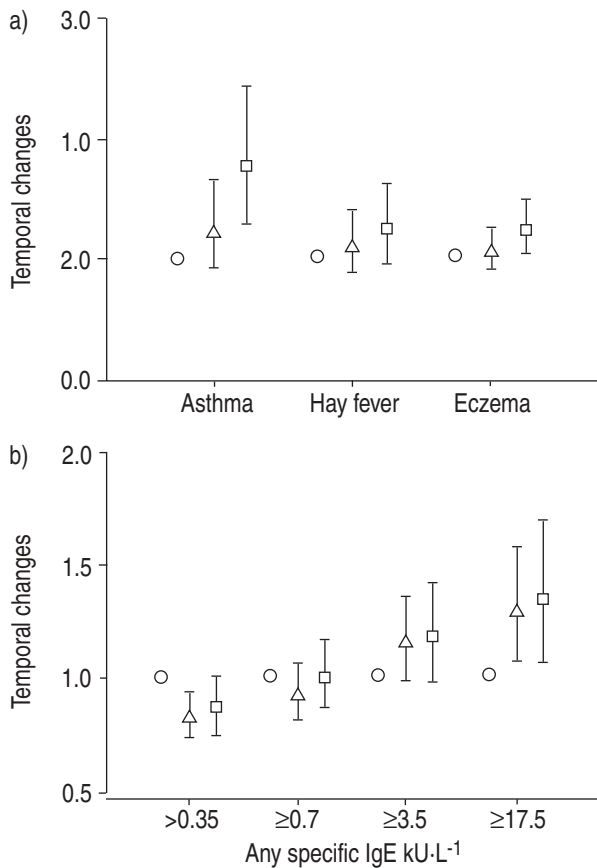


Fig. 1.—Temporal changes of prevalence of atopic diseases and allergic sensitization in children aged 5–14 yrs from three cross-sectional surveys in 1992–1993 (○, reference), 1995–1996 (△) and 1998–1999 (□) adjusted for area, age and sex. Data are presented as odds ratio and 95% confidence intervals. Ig: immunoglobulin.

urban areas. The degree of urbanization is known to be associated with prevalence of atopic diseases [23]. Secondly, the children of the three studies have different age ranges indicating different cohorts of children prior to and after German reunification and therefore with specific conditions during early life. Thirdly, methodological problems, in particular with standardization of the multitest Stallergenes devices used in the Leipzig study, could not be excluded [24]. Finally, the time frames of exposure during early childhood were different.

*Possible reasons for the increased prevalence of atopic diseases*

Besides these speculations, the discrepant study results should be interpreted with caution. Assuming a "sensitization window" during the first few months of life [25], one would expect that children who were born after German reunification, when tremendous changes in living and social conditions began would be more affected than children born before. In accordance with this assumption, studies did not find any increase of prevalence of allergic sensitization in children born prior to the reunification [2, 21]. Only the recently published expanded studies in Sachsen-Anhalt,

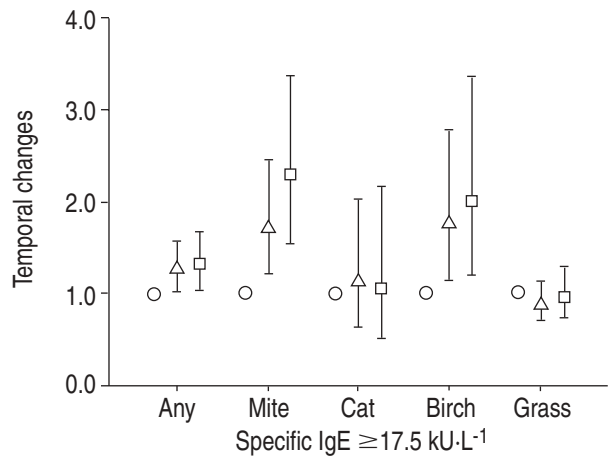


Fig. 2.—Temporal changes of strong allergic sensitization to mite, cat, birch and grass pollen in children aged 5–14 yrs from three cross-sectional surveys in 1992–1993 (○, reference), 1995–1996 (△) and 1998–1999 (□) adjusted for area, age and sex. Data are presented as odds ratio and 95% confidence intervals. Ig: immunoglobulin.

which included children born after German reunification for the first time, showed an increasing trend of prevalence of allergic sensitization [17].

The potential predictors of trends of allergic diseases did not affect the trend estimates for the Sachsen-Anhalt study [17], the Leipzig study [19] nor this study. Although remarkable, changes were found regarding several indoor factors, which may influence the development of allergic diseases in the three studies, inclusion of these factors in a multivariate

Table 3.—Adjusted prevalence of asthma, hay fever, atopic eczema and allergic sensitization by birth cohort and survey

	Year				
	1981	1984	1987	1990	1993
Hay fever					
Age					
6 yrs			2.1 <sup>#</sup>	2.3 <sup>¶</sup>	2.3 <sup>+</sup>
9 yrs		4.1 <sup>#</sup>	4.0 <sup>¶</sup>	5.0 <sup>+</sup>	
12 yrs	5.4 <sup>#</sup>	5.9 <sup>¶</sup>	6.1 <sup>+</sup>		
Asthma					
Age					
6 yrs			2.1 <sup>#</sup>	2.7 <sup>¶</sup>	3.9 <sup>+</sup>
9 yrs		2.1 <sup>#</sup>	2.2 <sup>¶</sup>	4.6 <sup>+</sup>	
12 yrs	2.2 <sup>#</sup>	3.0 <sup>¶</sup>	3.6 <sup>+</sup>		
Eczema					
Age					
6 yrs			8.6 <sup>#</sup>	11.0 <sup>¶</sup>	13.0 <sup>+</sup>
9 yrs		8.6 <sup>#</sup>	9.9 <sup>¶</sup>	11.8 <sup>+</sup>	
12 yrs	9.6 <sup>#</sup>	9.1 <sup>¶</sup>	10.2 <sup>+</sup>		
Strong allergic sensitization any IgE ≥ 17.5 kU·L <sup>-1</sup>					
Age					
6 yrs			3.9 <sup>#</sup>	7.4 <sup>¶</sup>	7.1 <sup>+</sup>
9 yrs		8.1 <sup>#</sup>	8.7 <sup>¶</sup>	11.9 <sup>+</sup>	
12 yrs	10.2 <sup>#</sup>	11.6 <sup>¶</sup>	10.3 <sup>+</sup>		

Data are presented as %. <sup>#</sup>: first survey in 1992–1993; <sup>¶</sup>: second survey in 1995–1996; <sup>+</sup>: third survey in 1998–1999.

Table 4. – Comparison of trends of prevalence of allergic diseases in Eastern German children during the 1990s

	Bitterfeld Study (the current study) 1992, 1995, 1998	Sachsen-Anhalt Sachsen-Study <sup>#</sup> 1991–2000	Leipzig <sup>¶</sup> 1992, 1995
Age yrs	5–14	5–7	9–11
Subject n	7632	~22000	4520
Hayfever <sup>+</sup>	(↑)	↑	↑
Asthma <sup>+</sup>	↑	↑	=
Eczema <sup>+</sup>	↑	↑	(↑)
Sensitization	NE	↑ (HDM)	↑ (any SPT)
SPT			NE
RAST	↓ (any RAST >0.35 kU·L <sup>-1</sup> ) ↑ (RAST ≥17.5 kU·L <sup>-1</sup> ) ↑ (HDM, birch) (RAST ≥17.5 kU·L <sup>-1</sup> )	↑ (birch) (RAST ≥0.7 kU·L <sup>-1</sup> ) ↑ (HDM) (RAST ≥0.7 kU·L <sup>-1</sup> )	
BHR <sup>§</sup>	↑		=

SPT: skin-prick test; RAST: radioallergosorbent test; BHR: bronchial hyperresponsiveness; HDM: house dust mite; NE: not examined; ↑: significant increase of prevalence; =: no significant change in prevalence; (↑): marginally significant increase in prevalence; ↓: significant decrease of prevalence. <sup>#</sup>: [17, 18]; <sup>¶</sup>: [19]; <sup>+</sup>: lifetime prevalence of doctors diagnoses; <sup>§</sup>: decrease of forced expiratory volume in one second ≥9% from baseline after cold air challenge.

regression model only marginally changed the crude estimates for temporal changes.

The prevalence of the three oldest birth cohorts did not show any remarkable differences in prevalence of strong allergic sensitization and atopic eczema (table 3). In particular, 6-yr-old children born after the German reunification showed a higher prevalence of strong allergic sensitization and atopic eczema than children of the same age born before 1990. A similar, although attenuated association was found for the 9-yr-old children (table 3). These results support the hypothesis that early life is an important factor in the development of atopic diseases. Furthermore, it argues strongly against the assumption that the trend is exclusively driven by an increased awareness.

The increased prevalence of atopic diseases in Eastern German children is at least partly due to the change in the Eastern German housing and living conditions, and could be assessed by parallel examinations of children in Eastern and Western Germany. Preliminary results of the only study of this type showed a steeper increase in prevalence of asthma, hay fever, and allergic sensitization to birch pollen, house dust mites, and milk in Eastern German children [17].

The levels of TSP and SO<sub>2</sub> decreased tremendously during the 1990s in Eastern Germany [14, 15]. Nevertheless, this ecological association between the decreasing levels of air pollutants and the prevalence of atopic diseases should be interpreted with caution. No valid conclusion on the effect of air pollution on the development of atopic disease could be drawn from this association. It was argued that the lower prevalence of asthma and hay fever in Eastern European countries indicated that air pollution does not play a major role in the onset of these diseases. This might be relevant for TSP and SO<sub>2</sub>, but may be irrelevant for specific chemical or physical properties of particulate matter and gaseous pollutants such as nitrogen dioxide. Whether the increase of nucleation mode particles concentration (particles <30 nm in geometric diameter) in the study areas between 1993

and 1999 [15] had any effect on the onset of atopic diseases requires further investigation.

Furthermore, it could be argued that the increasing prevalence of atopic diseases is indirectly caused by the decreased exposure to "classical" pollutants such as TSP and SO<sub>2</sub>. The decline of these pollutants goes along with major improvements of nonallergic respiratory health in Eastern German children [14, 20]. If these pollutants affect the onset of nonspecific respiratory infections, particularly during early life, one may speculate that the decrease of prevalence of these (ambient) pollution-related infections might enhance the development of atopic diseases.

#### Strengths and limitations of this study

A major strength in this study is that identical methods including an identical questionnaire were used in the three surveys. Specific IgE levels were analysed by the CAP-FEIA system (Pharmacia, Freiburg, Germany) using the same laboratory. Since temporal changes of prevalence of strong allergic sensitization differed between the three age groups (table 3), differences in analytical issues are unlikely. One potential strength of the analysis is that the results of the three study areas were pooled. There were differences in several health indicators, e.g. allergic status between children of the three study areas. These differences are described in detail elsewhere [22]. However, the direction and magnitude of the changes in each area were similar (data not shown), and when interaction term with study area was included in the multiple logistic regression model, comparable trends were found for each study location. A further potential limitation is the lower participation rate in the second and third survey. The lower participation rates did not lead to a selection bias regarding education, which is a marker for socioeconomic status. Because there was no difference in the distribution of educational levels of parents participating in the three surveys, this selection bias as regarded as negligible.

To conclude, the prevalence of asthma, hay fever, and atopic eczema increased in Eastern German children. Although the overall prevalence of allergic sensitization to common aeroallergens did not increase, the prevalence of strong allergic sensitization (RAST  $\geq 17.5$  kU·L<sup>-1</sup>) increased, which might affect the onset of clinical manifestations of atopic disease. The increased prevalence in children born after 1989 indicated that a "Western lifestyle" in very early childhood might drive the temporal changes of prevalence of atopic diseases and strong allergic sensitization.

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