The Association between Self-Reported Symptoms of Asthma and Allergic Rhinitis and Self-Reported Traffic Density on Street of Residence in Adolescents

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We examined the association between self-reported symptoms of asthma and allergic rhinitis and self-reported exposure to motor vehicle traffic in adolescents in Münster, Germany. A total of 3,703 German students age 12–15 years completed a written and video questionnaire in 1994–1995. We found positive associations between both wheezing and symptoms of allergic rhinitis during the past 12 months and self-reported frequency of truck traffic. The sex- and age-adjusted prevalence odds ratios and 95% confidence intervals (CI) for truck traffic, contrasting the categories "frequent" and "constant" against "never," were, for wheezing obtained by written questionnaire: 1.53 (95% CI = 1.15–2.05) and 2.15 (95% CI = 1.44–3.21); for wheezing obtained by video questionnaire: 1.61 (95% CI = 1.26–2.07) and 2.47 (95% CI = 1.74–3.52); and for symptoms of allergic rhinitis: 1.71 (95% CI = 1.36–2.15) and 1.96 (95% CI = 1.40–2.76), respectively. We found a similar positive association with self-reports on traffic noise. Putative confounding variables, including indicators of socioeconomic status, smoking, etc, did not alter these associations substantially. The results correspond closely with findings of a survey carried out in 1991 in Bochum, Germany. Our results support the hypothesis that exposure to motor vehicle traffic is related to symptoms of asthma and allergic rhinitis in children, but we cannot rule out misclassification due to self-reports of traffic exposure. (Epidemiology 1996;7:578–582)

Keywords: allergies, asthma, wheezing, rhinitis, traffic density, air pollution, childhood, ISAAC.

Several studies and reports have indicated an association between motor vehicle emissions and morbidity from respiratory and allergic disorders.[1-11] We have recently reported an association between self-reported wheezing and allergic rhinitis and self-reported traffic density on the street of residence among adolescents in the city of Bochum, Germany.[12]

The aims of this study were: (1) to examine whether the observed association in Bochum[12] between motor vehicle exposure and atopic respiratory symptoms could also be found in Münster; (2) to investigate a similar potential association with self-reported traffic noise; and (3) to assess the similarity of the associations between the Münster and Bochum studies.

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Subjects and Methods

A cross-sectional study of school children was conducted in Münster, a city of approximately 270,000 inhabitants in the northwest of Germany. Münster is primarily an administrative city, with only a few industrial areas. It has a wide range of residential settings, including suburban and rural areas with very different traffic densities. Thirty-six of 45 schools in the city were chosen at random to participate in the study. The survey targeted all children in the two school grades with the highest proportion of 13- to 14-year-olds. Data were collected from August 1994 through January 1995. Field work and data collection in classrooms were conducted in a standardized way.[13,14]

The study in Münster is part of the International Study of Asthma and Allergies in Childhood (ISAAC), which uses a standardized written (WQ) and video questionnaire (VQ) on wheezing.[13,15] The WQ contains standardized questions on symptoms of allergic rhinitis. Information on sociodemographic characteristics, exposure to traffic in the residential street, and additional factors was also requested from the students on the WQ.

For this analysis, we used responses to the following questions to define the health outcome: (1) Have you had wheezing or whistling in the chest in the last 12 months? Yes/No (WQ); (2) A positive response to at least one of the first three video scenes regarding wheez-

ing during the last year (VQ); and (3) In the past 12 months, have you had a problem with sneezing, or a runny, or a blocked nose when you did not have a cold or the flu? Yes/No (WQ). We used these symptom-related health outcome variables instead of information on disease diagnoses to minimize possible bias due to diagnostic labeling.

Information concerning traffic density on the residential street was obtained with two questions: (1) How often do trucks pass through your residential street on weekdays? (Never/Seldom/Frequently/Constantly); and (2) During the day, is the traffic noise in your residential street so intense that you have to close the windows in order not to be disturbed? (Yes, constantly/Yes, frequently/Yes, seldom/No, never). Residential traffic level was assessed because it was assumed that children of this age group spend most of their time in or near their home. In Germany, children attend school for 5–6 hours per weekday, on average.

The ISAAC questionnaire was completed by 4,003 (93.9%) of all eligible students of the sampled schools in Münster. To avoid bias due to differences in life-style and interpretation of questions, we restricted the analysis to 12- to 15-year-olds with German nationality (N = 3,703). We present univariate descriptive statistics of exposure and outcome variables and the frequency of symptoms by category of traffic exposure. We excluded participants with missing values on questions from analyses involving those questions. We used multivariate logistic regression (MLR) analysis to calculate age- and sex-adjusted prevalence odds ratios (PORs) for the symptom variables, comparing different exposure categories, although neither sex nor age showed a strong confounding effect. We included the following variables one by one in the age- and sex-adjusted MLR model to assess their confounding effect: active smoking, passive smoking, type of secondary school, own bedroom, number of older siblings, pets, parental history of atopic disease (that is, asthma, hay fever, and eczema), duration of living in present dwelling, and energy source for cooking. Then we included all of the above variables in one MLR model to assess their joint confounding effects. Finally, we also analyzed the interaction of each of these factors with traffic exposure.

The ISAAC study in Münster was carried out in almost the same way as the ISAAC pilot study in Bochum in 1991.[16] They both used the same sampling scheme, age groups, and study instruments (WQ and VQ). The question on frequency of truck traffic exposure on street of residence was identical in both studies. In the question on the period prevalence of wheezing, the Bochum WQ referred to the "last year" and the Münster WQ to the "last 12 months." To compare the associations between symptoms and self-reported truck traffic exposure between Bochum and Münster, the two datasets were analyzed in the same way in an additional analysis, and for the purpose of comparability with our previous publication,[12] we did not exclude non-German students. Since each of the variables age, sex, active smoking, passive smoking, or parental history of asthma was indicated as a confounder in either the Bochum or the Münster data, we included these variables in the MLR models. We excluded students with incomplete data on any of these variables from this analysis. This exclusion reduced the size for the comparative analysis from 4,003 to 3,270 in Münster and from 2,050 to 1,943 in Bochum. In the joint analysis of Münster/Bochum data, we included a 0–1 city variable, along with the interaction of city with all of the included variables. The questions on rhinitis were not directly comparable between the cities.

TABLE 1. Selected Characteristics of the Study Population (N = 3,703)

	Number	%
Sex		
Male	1,830	49.4
Female	1,873	50.6
Age (years)		
12	653	17.6
13	1,531	41.3
14	1,201	32.4
15	318	8.6
Frequency of truck traffic		
Never	965	26.6
Seldom	1,899	52.3
Frequent	585	16.1
Constant	180	5.0
Missing values	74	
Frequency of intense traffic noise		
Never	2,854	78.0
Seldom	598	16.3
Frequent	123	3.4
Constant	84	2.3
Missing values	44	
Symptoms of asthma and allergic rhinitis		
Wheezing and whistling in last 12 months: WQ	520	14.3
Missing values	79	
Wheezing and whistling in last year: VQ*	809	22.5
Missing values	102	
Symptoms of allergic rhinitis in last 12 months	1,065	29.3
Missing values	70	

* Positive response to any of the first three video scenes.

Results

The self-reported 12-month period prevalence of wheezing and symptoms of allergic rhinitis assessed by WQ was 14.3% and 29.3%, respectively (Table 1). 22.5% of the students responded affirmatively to at least one of the first three scenes in the VQ. Approximately a quarter of the adolescents indicated no truck traffic on their residential street, whereas 16.1% reported frequent truck traffic and 5.0% reported constant truck traffic on weekdays. Three quarters of the students reported that they were never disturbed by intense traffic noise during the day. Only a few adolescents indicated frequent (3.4%) or constant (2.3%) disturbance due to traffic noise.

TABLE 2. Self-Reported 12-Month Period Prevalence of Symptoms of Asthma (Wheezing) and Allergic Rhinitis by Self-Reported Traffic Density on Street of Residence (N = 3,703)

	Wheezing (WQ)*		Wheezing (VQ)†		Allergic Rhinitis	
Traffic Density	Number	%	Number	%	Number	%
Frequency of truck traffic						
Never	116	12.3	180	18.9	231	24.3
Seldom	254	13.6	393	21.3	535	28.8
Frequent	102	17.9	158	28.1	203	35.4
Constant	41	23.3	62	36.5	68	38.9
Missing values	148		173		142	
Frequency of intense traffic noise						
Never	375	13.4	564	20.3	753	26.9
Seldom	102	17.6	171	29.6	211	35.9
Frequent	22	18.5	37	31.4	48	40.0
Constant	16	19.3	27	33.8	34	41.5
Missing values	119		143		112	

* Written questionnaire.
† Video questionnaire.

TABLE 3. Prevalence Odds Ratios (PORs) with 95% Confidence Intervals (CI) for the Association between Symptoms of Asthma (Wheezing) and Allergic Rhinitis and Traffic Density on Street of Residence

	Wheezing (WQ)		Wheezing (VQ)		Allergic Rhinitis	
Traffic Density	POR*	95% CI	POR*	95% CI	POR*	95% CI
Frequency of truck traffic		N = 3,555		N = 3,530		N = 3,561
Never†	1.00		1.00		1.00	
Seldom	1.11	(0.88–1.41)	1.13	(0.93–1.38)	1.26	(1.05–1.51)
Frequent	1.53	(1.15–2.05)	1.61	(1.26–2.07)	1.71	(1.36–2.15)
Constant	2.15	(1.44–3.21)	2.47	(1.74–3.52)	1.96	(1.40–2.76)
Frequency of intense traffic noise		N = 3,584		N = 3,560		N = 3,591
Never†	1.00		1.00		1.00	
Seldom	1.37	(1.08–1.75)	1.63	(1.33–2.00)	1.52	(1.26–1.83)
Frequent	1.45	(0.90–2.34)	1.79	(1.20–2.67)	1.79	(1.23–2.60)
Constant	1.53	(0.87–2.66)	1.99	(1.23–3.19)	1.89	(1.21–2.96)

* Adjusted for age and sex.
† Referent.

There was a positive and graded association between traffic density on street of residence and reported symptoms, indicated in Table 2 by higher unadjusted prevalences of self-reported symptoms with higher reported frequency of truck traffic or traffic noise on street of residence. Table 3 gives the age- and sex-adjusted PORs with 95% confidence intervals (CI) for the association between self-reported wheezing and rhinitis symptoms and the indicators of traffic exposure. The PORs contrasting the "constant" against "never" categories range from 1.96 to 2.47 for truck traffic and from 1.53 to 1.99 for traffic noise, respectively. None of the above-mentioned potential confounding variables had a major confounding effect on the relation between measures of traffic density and symptoms of asthma or rhinitis.

We observed effect modification only for duration of living in the present dwelling for the relation between truck traffic and prevalence of symptoms of allergic rhinitis; the association between symptoms of allergic rhinitis and truck traffic was seen only in children who had lived at least 5 years in their present dwelling (Table 4). This effect modification persisted also in a combined analysis with all of the above-mentioned putative confounding factors. We found no such effect modification for wheezing or for the question on traffic noise.

The comparisons of effect estimates between Bochum and Münster are given in Table 5. Since nationality, house pets, and the adolescent's having his/her own bedroom showed no confounding effect, these variables used in the Bochum paper were not included in the final model. Similar to the results in Table 3, we observed a constant positive association between truck traffic and self-reported wheezing for each city separately and for the combined data. Although the period prevalence of wheezing was lower in Münster than in Bochum, the point estimates of the adjusted PORs for the different categories of exposure and symptoms are remarkably similar in the two studies.

Discussion

Our data show a positive association between both self-reports of wheezing and symptoms of allergic rhinitis and self-reports of traffic density (frequency of truck traffic and of intense traffic noise) on street of residence in Münster. In addition, we observed a remarkably similar positive association between self-reported wheezing and frequency of truck traffic in the cities of Münster and Bochum.

The ISAAC written and video questionnaires have been shown to be valid instruments to assess the prevalence of wheezing in adolescents.[17-19] Our measures of exposure to traffic emissions are also based on self-reports, however, and may be subject to

TABLE 4. Prevalence Odds Ratios (PORs) with 95% Confidence Intervals (CI) for the Association between Symptoms of Allergic Rhinitis and Frequency of Truck Traffic on Street of Residence, by Number of Years in Present Dwelling (N = 3,492)

	Symptoms of Allergic Rhinitis			
	≤5 Years in Present Dwelling		>5 Years in Present Dwelling	
Frequency of Truck Traffic	POR*	95% CI	POR*	95% CI
Never†	1.00		1.00	
Seldom	0.81	(0.58–1.14)	1.49	(1.20–1.85)
Frequent	1.36	(0.92–2.00)	1.82	(1.37–2.42)
Constant	1.02	(0.55–1.88)	2.57	(1.67–3.96)

* Adjusted for age and sex.
† Referent.

TABLE 5. Prevalence Odds Ratios (PORs) with 95% Confidence Intervals (CI) for the Association between Self-Reported Symptoms of Asthma (Wheezing) and Self-Reported Frequency of Truck Traffic on Street of Residence, by Study Area

Frequency of Truck Traffic	Wheezing					
	Münster 1994/1995 (N = 3,270)		Bochum 1991 (N = 1,943)		Münster and Bochum (N = 5,213)	
	POR*	95% CI	POR*	95% CI	POR†	95% CI
Written questionnaire						
Never‡	1.00		1.00		1.00	
Seldom	1.17	(0.91–1.51)	1.10	(0.78–1.53)	1.14	(0.93–1.39)
Frequent	1.51	(1.10–2.05)	1.54	(1.06–2.23)	1.53	(1.21–1.94)
Constant	1.77	(1.14–2.75)	1.88	(1.19–2.97)	1.84	(1.35–2.51)
Video questionnaire						
Never‡	1.00		1.00		1.00	
Seldom	1.11	(0.90–1.38)	1.26	(0.93–1.71)	1.16	(0.98–1.38)
Frequent	1.35	(1.04–1.77)	1.47	(1.05–2.07)	1.40	(1.14–1.72)
Constant	1.94	(1.33–2.84)	1.93	(1.26–2.96)	1.92	(1.45–2.53)

* Adjusted for age, sex, active smoking, passive smoking, and parental history of asthma.
† Also adjusted for city.
‡ Referent.

misclassification. First, truck traffic and traffic noise on the residential street may not accurately reflect the actual exposure to motor vehicle emissions that adolescents experience inside and outside their homes. Secondly, children with respiratory health problems and unaffected children may have different perceptions of the possible ill effects of motor vehicle traffic, which could result in preferential reporting of exposure among those who have respiratory symptoms. It is unlikely that the published results from the study in Bochum[12] had any influence on the responses of the adolescents in Münster, since the findings were not addressed in the local media.

We evaluated possible confounding effects for several variables in the Münster data. Because we were not able to obtain more precise information on socioeconomic status from the adolescent study participants, we approximated this potentially confounding factor by using the type of school attended and whether the student had his/her own bedroom. These indicators of socioeconomic status, like all of the other examined putative confounders, showed no major confounding effect in the MLR. We were not able, however, to control for other factors, such as molds, dampness, housedust mites, etc,[20,21] which could, at least in part, explain the observed associations between symptoms and motor vehicle traffic.

Furthermore, the observed association may not be a direct, but rather an indirect, effect of motor vehicle emissions. Those who live near busy roads may more often close their windows to keep the disturbing motor vehicle emissions like exhaust fumes and traffic noise out of their home. This practice may, as a consequence, change the indoor climate and may have an effect on indoor allergen concentration.

Our finding of an association between hay fever symptoms and truck traffic in children who have lived more than 5 years in their present dwelling adds credibility. It suggests that duration of traffic exposure plays a role in the relation between symptoms of allergic rhinitis and frequency of truck traffic in residential streets (Table 4). We found no similar effect modification, however, for wheezing or for the question on traffic noise.

The positive association between symptoms and motor vehicle density was also seen for the question on intense traffic noise. This information may be a good indicator of motor vehicle emissions that adolescents experience inside their home.

Several previous studies have provided evidence that exposure to motor vehicle emissions can exacerbate respiratory symptoms of allergic origin or increase the incidence of allergic disease. For example, various animal studies have shown an association between allergy and components of motor vehicle exhaust fumes.[6,7,22-25] Experimental studies on humans have also indicated an association between respiratory symptoms and traffic pollution.[8,26,27] A number of occupational studies have shown an association between exposure to traffic exhaust and adverse effects on respiratory symptoms and lung function,[28-32] whereas others failed to find such an association.[33-35]

Several epidemiologic studies in adults indicate an association between exposure to motor vehicle traffic at residence and morbidity from respiratory and allergic disorders.[2,3,36] Studies in children have also reported adverse respiratory effects due to exposure to motor vehicle traffic.[1,4,11,12]

A recent study indicated that not only exhaust fumes but also large quantities of respirable abraded tire fragments containing potentially allergenic latex particles are partly responsible for traffic-related air pollution.[10] Because truck tires contain higher amounts of natural latex, the reported frequency of truck traffic on street of residence may be a useful indicator of exposure not only to diesel exhaust but also to such respirable particles.

The results of our study provide additional evidence that self-reported traffic exposure is related to self-reported wheezing and symptoms of allergic rhinitis in adolescents. Since we cannot rule out preferential reporting, we do not know whether these findings are the result of a causal association or a reflection of concerns among adolescents about possible ill effects of traffic emissions.

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