

Title: Respiratory symptoms in children living near busy roads and their relationship to car and truck traffic: Results of an Italian multicenter study (SIDRIA 2)

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Abstract:**Background**

Epidemiological studies have provided evidence that exposure to vehicular traffic increases the prevalence of respiratory symptoms and may exacerbate pre-existing asthma in children

The aim of this study was to investigate whether there were specific effects of cars and trucks traffic on current asthmatic symptoms (i.e. wheezing) and persistent cough or phlegm.

Methods

The survey was conducted in 2002 in 12 centers of Northern, Center and Southern Italy, different in size, climate, latitude and level of urbanization. Standardized questionnaires were used to collect information on health outcomes and exposure to traffic among 6-7 and 13-14 years old children and adolescents. A questionnaire filled in by parents was available for 33632 subjects (response rate: 86.7%).

Results

Overall traffic density was weakly associated with current asthma symptoms but there was a stronger association with persistent cough or phlegm (high traffic density OR=1.22, 95% CI 1.06-1.41). Car and truck traffic were independently associated with cough and phlegm. The strongest association was found when asthmatic symptoms and persistent cough or phlegm were combined as the final outcome (continuous transit of trucks OR=2.03, 95% CI 1.59-2.58).

Conclusions

Children living near streets with intense traffic are at higher risk for respiratory effects. Traffic exposure is mainly associated with asthma with persistent cough or phlegm and the effects are stronger for truck exposure.

Background

Vehicular traffic is a major source of outdoor air pollution. Several studies have reported associations between exposure to traffic pollutants in the zone of residence and increased frequency of respiratory tract illnesses [1-10]. A specific role of diesel exhaust from heavy traffic has been suggested in some of these studies [4, 5, 7], and airway inflammation due to exposure to diesel exhaust seems the likely biological mechanism [11, 12]. With respect to the type of respiratory disorder, consistent associations have been found between exposure to traffic fumes and bronchitis symptoms, while the role of these exposures in the etiology of asthma is still unclear [13].

The SIDRIA project - Studi Italiani sui Disturbi Respiratori nell'Infanzia e l'Ambiente [14-16] - is a large multi-center, population-based study conducted in the framework of the International Study of Asthma and Allergies in Childhood (ISAAC) [17]. The findings from SIDRIA-1, conducted in 1994-1995, showed a positive association between indicators of air pollution from heavy vehicular traffic in the street of residence and a wide range of respiratory disorders in children living in highly urbanized areas [18]. However, it was not possible to assess the independent effects of car and truck traffic in that study as the information was not available.

A second phase of SIDRIA was conducted in 2002 to evaluate time trends in the prevalence of respiratory disorders in childhood, according to the ISAAC Phase 3 protocol [19], and to investigate the role of several potential risk factors identified in SIDRIA-1. In this paper, based on the data from SIDRIA-2, we present an analysis of the relation between indicators of road traffic pollution and several chronic respiratory symptoms. The main purpose of this analysis was to evaluate the possible independent respiratory effects of each type of traffic exposure (truck traffic or car traffic). Since chronic cough may be a manifestation of asthma or it may occur also in otherwise healthy children mainly as a result of "back to back" respiratory infections or of recurrent or chronic rhino

sinusitis with postnasal drip [20], we have specifically separated asthma symptoms and symptoms of persistent cough or sputum production (persistent cough or phlegm).

Methods

The SIDRIA-2 study design has been described elsewhere [15, 16, 21] and it will be only summarized here. The survey was conducted in 2002, between January and May, in 12 centers (Bari, Colleferro, Emilia-Romagna, Empoli, Florence, Mantova, Milan, Palermo, Rome, Siena, Turin, Trento) of Northern, Center and Southern Italy, different in size, climate, latitude and level of urbanization. Eight of these centers had already participated in SIDRIA-1 [18]. The protocol of the study was approved by Ethics Committee of the Catholic University in Rome.

The sample included 22442 children (6-7 years old) and 16336 adolescents (13-14 years old) attending respectively the first two grades of the primary school and the last year of the middle school. The primary sampling units were schools, both public and private, weighted for the number of attending subjects. Each center contributed with at least 1000 subjects for each age group. To collect information on the medical history of the children, we used standardized, self administered questionnaires that included also the relevant ISAAC-Phase III questions on asthma, rhinitis and eczema symptoms, and questions on various known or suspected risk factors. For children (6-7 years old), all questionnaires were completed by parents. According to the standard ISAAC protocol [17], the questionnaires for adolescents were filled by adolescents themselves. However, in the SIDRIA study, another questionnaire, including questions on both symptoms and risk factors, was also completed by the adolescents' parents. For reasons of consistency and comparability between age groups, the current analyses are based on the parental questionnaires for both age-groups.

Children with “current asthma symptoms” were defined as those reporting in the past 12 months at least one of the following: one or more wheezing episodes, shortness of breath with wheeze, wheeze with exercise, dyspnoea, asthma, morning chest tightness or those reporting treatment for medically diagnosed asthma or a hospital admission for asthma in the last 12 months.

Children were defined as having “persistent cough or phlegm” if they reported cough or phlegm (in the absence of a cold) for two or more months a year, or if they had mucous nasal discharge, nasal congestion and nocturnal cough (in the absence of a cold) for more than 7 consecutive days for at least 3 or 4 times in the last twelve months, or for at least 3 consecutive months (i.e. sinusitis-like symptoms).

Questions on traffic included a parental subjective evaluation of traffic density in the zone of residence (“absent”, “low”, “moderate” or “high”) and of the daily frequency of passing cars and trucks in the street of residence (“never or seldom”, “sometimes”, “frequently”, “continuously”).

Odds ratio (OR) and 95% confidence intervals (95% CI) were estimated with multiple logistic regression analyses. The basic analyses were for “current asthma symptoms” and “persistent cough or phlegm”, but we also conducted analyses of current asthma symptoms without persistent cough or phlegm, persistent cough or phlegm without current asthma symptoms, and the combination of the two conditions. For “persistent cough or phlegm”, the analyses focused on the possible independent effect of cars and trucks transit in the street of residence. In order to obtain sufficient numbers in each category, car transit was recoded into three categories (“absent/sometimes”, “frequently” and “continuously”) and truck transit was also recoded into three categories (“absent”, “sometimes” and “frequently/continuously”).

Potential confounding factors included in the multiple logistic regression models were: sex, age, parental asthma or atopy (asthma or rhinitis or eczema), parental education (higher educational level between parents as a proxy of socioeconomic status – SES), passive smoke at home (at least one smoker -mother, father or others- in the household), indoor mould/dampness and study area. The effect of cluster sampling by school was considered and each regression model was adjusted for autocorrelation within schools. In order to evaluate the role of potential effect modifiers, we performed subgroup analyses for different factors (age, gender, latitude, parental education, smoking, parental asthma or allergies), in each case considering the associations of truck traffic exposure (frequent or continuous vs never) and the investigated respiratory symptoms. All analyses were conducted using STATA 9 (Stata Corporation, College Station, Texas).

Results

The parental questionnaire was completed for 20016 6-7 years old (response rate 89.2%) and for 13616 13-14 years old (response rate 83.3%). Table 1 shows the combined prevalence of current asthma symptoms and persistent cough or phlegm. Overall, 13.5% of children (95% CI 13.2-13.9%) were reported to have current asthma symptoms, and 10.2% (95% CI 9.9-10.6%) to have persistent cough or phlegm. For 4.1% (95% CI 3.9-4.3%) of the subjects, persistent cough or phlegm and asthma symptoms were concomitant.

The prevalences of respiratory symptoms in the various subgroups are shown in Table 2. Respiratory symptoms were more frequent if a parental history of asthma, rhinitis or eczema was reported, among subjects exposed to passive tobacco smoke and in the presence of moulds/dampness in the child's bedroom. The prevalence of respiratory symptoms increased inversely with parental education, and directly with urbanization level.

Table 3 shows the associations of traffic indicators with current asthma symptoms and with persistent cough or phlegm. Reported high traffic density, continuous car transit and continuous truck transit in the street of residence were weakly associated with current asthma symptoms. There were stronger associations of reported high traffic density, continuous car transit and continuous truck transit with persistent cough or phlegm. The associations were generally stronger for truck transit than for car transit.

The relationship between these traffic indicators and the respiratory outcomes was explored in detail (Table 4) evaluating the associations with asthma symptoms without persistent cough or phlegm, persistent cough or phlegm without asthma and the combination of the two conditions. Current asthma symptoms, when alone, were only weakly associated with high traffic density, continuous car and continuous truck transit. Traffic exposure indicators were more strongly associated with persistent cough or phlegm, and particularly with asthma accompanied by persistent cough or phlegm. For this last condition (asthma with persistent cough or phlegm) there were strong and significant associations for all the indicators.

The analyses of the independent and joint effects of truck traffic and car traffic on the risk of persistent cough or phlegm are shown in Table 5.

In some categories the numbers are relatively small and the effect estimates are therefore unstable. The table confirms an independent effect of truck transit on persistent cough or phlegm (OR=1.39, 95% CI 0.93-2.08), and also shows a similar association for car transit (OR=1.34, 95% CI 1.01-1.77).

Further analyses were performed to examine possible effect modifiers of the association with frequent or continuous truck transit (Figure 1). Higher risks were observed for females for current asthma symptoms without persistent cough or phlegm (OR=1.22, 95% CI 1.05-1.40), persistent

cough or phlegm without asthma (OR=1.63, 95% CI 1.35-1.96), and the combination of the two conditions (OR=1.91, 95% CI 1.46-2.50) than for males (OR=0.98, 95% CI 0.94-1.15, OR=1.23, 95% CI 1.04-1.46 and OR=1.31, 95% CI 1.05-1.63 respectively). Persistent cough or phlegm without asthma were more associated with truck transit in the Northern areas of the Country (OR=1.90, 95% CI 1.62-2.22) than in the Central and in the Southern areas (OR=1.14, 95% CI 0.92-1.41 and OR=1.00, 95% CI 0.68-1.45, respectively); a similar pattern was observed for the combination of symptoms. Higher associations of persistent cough or phlegm without asthma with truck traffic were observed for the lowest level of parental education (13 years or less: OR=1.81, 95%CI 1.45-2.25) than for the highest levels (high school/University: OR= 1.25, 95%CI 1.08-1.45). This difference in the association by parental education was lower for the combination of symptoms, while no difference was observed for current asthma symptoms without persistent cough or phlegm. Age, level of urbanization, smoking, parental susceptibility (asthma or allergies) did not act as effect modifiers.

Discussion

This study confirms our previously-reported associations between frequency and density of traffic in the street of residence and current respiratory symptoms in children [18]. For all indicators of traffic density and frequency, an increase in symptoms by level of exposure was observed. The strongest associations were for persistent cough or phlegm and truck traffic, although an independent effect of continuous car traffic was found. Traffic fume exposure was weakly associated with current asthma symptoms, but the association was stronger if asthma was accompanied by persistent cough or phlegm.

Few published studies have analyzed the effects of traffic in relationship to combinations of respiratory outcome such as asthma symptoms and persistent cough or phlegm. A positive association of air pollution with bronchitis symptoms, but not with asthma, has been reported in

some studies [3, 6]. Other studies found both associations; e.g. Kim et al. (2004) found a significant increase in the risk of bronchitic symptoms and asthma in relation to higher level of traffic related to pollution in a US area with relatively clean air [22]. However, the findings of different studies should be compared with caution, because the definition of asthma adopted may be different and it can often include symptoms that may be related to bronchitis rather than to asthma [23]. In fact we have found an increased risk of asthma symptoms in children exposed to car and truck traffic fumes, essentially restricted to those who also reported persistent cough or phlegm. There are two possible explanations for these findings. Firstly, it is possible that these children only had chronic bronchitis and did not have asthma symptoms, i.e. that they were “misdiagnosed” by our asthma symptom questionnaire [24]. The second, and perhaps more likely explanation, is that these children experienced an increased risk for a form of asthma that also involved persistent cough and phlegm.

Several previous questionnaire-based studies and surveys that used objective traffic counts as exposure metrics, have suggested that heavy traffic powered by diesel engines is more harmful for respiratory health than light traffic powered by gasoline engines [13, 23]. When we analyzed the effects of car and truck traffic separately on persistent cough or phlegm, we found a stronger association with heavy traffic exposure (Table 4), consistent with the findings from other studies [4, 7, 9]. In the study conducted by Janssen and coworkers (2003), chronic respiratory symptoms were positively associated with high truck traffic and with air pollutants related to truck traffic counts [7]. In a cross-sectional study conducted on a sample of 1242 children (7-12 years old) [9], respiratory symptoms were more prevalent among children attending schools located close (<100 m) to highways, particularly if the highway had a high truck traffic density.

There is epidemiological evidence that chronic exposure to diesel exhaust may be associated with increased severity of respiratory effects, e.g. children living near busy diesel trucking streets have

shown decreased lung function [4]. Boezen and coworkers (1999) observed that children with bronchial hyperresponsiveness (BHR) and high serum IgE responded more strongly to various measures of ambient air pollution which may act as surrogate for diesel exhaust particles [25]. A re-analysis of three longitudinal studies conducted in USA showed a clear effect of PM_{2.5} (Particulate Matter with aerodynamic diameter less than 2.5 micron) both on peak expiratory flow (PEF) and on the prevalence of respiratory symptoms in children [26].

We found significant associations of car traffic with persistent cough or phlegm, although these were generally weaker than the associations for truck traffic (Tables 4 and 5). These findings could indicate that car traffic may also represent a source of pollutants increasing the risk of chronic cough or phlegm. However, these findings could also be related to the very high, and still increasing, number of cars powered by diesel engines at present circulating in European countries, and does not necessarily indicate that other types of car fume exposure also increase the risk of respiratory symptoms.

Children exposed to both, continuous car traffic and frequent or continuous truck transit, showed the highest risk of persistent cough or phlegm (Table 5). The joint effect of car and truck exposure (OR=1.59) is approximately what we would expect under an additive model ($1+0.34+0.39 = 1.73$), given the independent effects of cars (OR=1.34) and trucks (OR=1.39). This is consistent with the hypothesis that truck and car traffic involve similar exposures (e.g. diesel fumes) so that their effects would be additive.

With respect to exposure to heavy traffic and related respiratory outcomes, we found stronger associations in females. An increased susceptibility of girls to air pollution has been reported by several investigators [4, 9, 10, 22] and was partially observed also in SIDRIA-1 [18]. A higher pollutant-to-lung volume ratio that results from larger airways relative to lung size in girls than in

boys and enhanced cholinergic irritability could be considered as possible explanations [27, 28]. A gradient in the geographical distribution of the ORs for truck exposure and persistent cough or phlegm (with or without asthma) is present in our data. This trend is consistent with the hypothesis that geo-climatic factors characterizing the Northern regions do favor accumulation of atmospheric pollutants. We do not have a direct interpretation for the strong association between truck frequency and persistent cough or phlegm in children of less educated parents, but it should be noted that the same type of effect modification by socioeconomic status has been seen in other studies of air pollution, regarding short term [29, 30] and long term effects [31].

Our findings are based on a large random general population sample with a high response rate (86.7%). The information on symptoms of asthma and persistent cough or phlegm included items derived from standardized validated questionnaires, that have been used in previous epidemiological studies in this population [32] and internationally [17]. Recently, the quality of self reported exposure has been questioned, particularly in studies on respiratory health in children [33-35]. However, the information about traffic exposure has been validated in both SIDRIA phases. In the previous SIDRIA study, in the city of Turin, the categories of the “truck frequencies” in the street of residence were found to be good predictors of the hourly median number of heavy vehicles passing in the street [18]. Similarly, in the city of Rome, the subjective evaluation of the traffic density was found to be positively correlated to nitrogen dioxide (NO₂) pollution measured with passive samplers [36]. Furthermore, in Rome, among the 2107 children (9-11 years old) included in the ISAAC phase II [37], the subjective evaluation of the traffic density in the area of residence was found to be related to NO₂ pollution estimated through a land-use regression model [38].

Within SIDRIA-2 a validity study has been conducted in Turin, where data on urban traffic flow for 139 selected streets were available, corresponding to the addresses of 887 subjects in our study (out of 3249 respondents reporting complete information on address and street traffic). The traffic

indicators from the questionnaires were strongly associated with the median number of daily vehicles passing on average in the street in working hours, and particularly the indicator of car transit (“absent/sometimes” [n=51] = 7378 vehicles, “frequently” [n=205] = 9840 vehicles, “continuously” [n=629] = 15276 vehicles).

Certainly, other exposure matrix could be considered to estimate individual exposure of the children. There are excellent examples in other countries where some authors have combined GIS (Geographical Information System) methodology, population data, and traffic counts to estimate personal exposure [2, 39, 40]. However, similar data are surrogates of the true exposure too. The questionnaires related to traffic pollution in the street of residence, and we did not take account of other exposures such as those close to the schools. However, this is likely to have led to a small random misclassification of the exposures in the participants, but is very unlikely to have severely biased the observed associations. We adjusted for several known risk factors for respiratory symptoms and the magnitude of residual confounding, if any, should be small.

Although the specific set of airborne toxicants that facilitate and promote respiratory effects are still not known, our findings add further evidence to support a causal effect of exposure to traffic road pollution on respiratory illnesses in childhood. The adverse effects of air pollution represent a relevant public health problem, since exposure to traffic exhausts involves a large proportion of children having found that about 60% of children in our study are exposed to frequent or continuous car traffic and that about 20% of children are exposed to frequent or continuous truck traffic fumes.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

GB was involved in statistical analysis, interpretation of the results, and drafted the manuscript. EM assisted in the planning of the study, data collection, data management and analysis and helped drafting the manuscript. CG was national coordinator of the study, conceived the study and participated in its design and conduction and in the manuscript preparation. NP contributed to data analysis, interpretation of the results, and critical review of the manuscript. FF, LB, ECh, GG, PS, VDO, LA, CG and GC were local coordinator and were involved in the conception and design of the study, acquisition of local data, interpretation of the results, and critical review of the manuscript. AB and GV participated in the study design, statistical analyses, and revision of the manuscript. MB, RP and LA, as respiratory specialists, were involved in medical data collection, interpretation of the results and revision of the paper. EC, as air quality specialist, contributed to exposure assessment and critical review of the manuscript. All of the authors have read and approved the final version of the manuscript.

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Figure legends

Figure 1: Associations between exposure to truck transit and respiratory symptoms, by several characteristics. The figure reports the associations (OR and 95% CI) between exposure to truck transit (frequent/continuous *vs* never) and current asthma symptoms (without persistent cough or phlegm), persistent cough or phlegm (without current asthma symptoms), current asthma symptoms with persistent cough or phlegm, by different factors (age, gender, latitude, parental education, smoking, parental asthma or allergies). All ORs were adjusted for potential confounder, excluding the stratification factor.

Tables

Table 1. Prevalence of respiratory outcomes investigated in a sample of Italian schoolchildren.

		Current asthma symptoms		
		YES n (%)	NO n (%)	TOTAL
Persistent or phlegm	YES n (%)	1382 (4.1%)	2065 (6.1%)	3447 (10.2%)
	NO n (%)	3170 (9.4%)	27015 (80.0%)	30185 (89.8%)
	TOTAL	4552 (13.5%)	29080 (86.5%)	33632 (100%)

Table 2. Prevalence (%) of current respiratory symptoms by various subgroups (N=33632)

	Current asthma symptoms	Persistent cough or phlegm
	% (n)	% (n)
Total	13.5 (4552)	10.2 (3447)
Age		
6-7 year olds	13.7 (2736)	12.1 (2418)
13-14 year olds	13.3 (1816)	7.6 (1029)
Gender		
male	14.6 (2531)	11.0 (1897)
female	12.4 (2012)	9.5 (1545)
Parental atopy		
yes	17.6 (2376)	13.0 (1752)
no	10.8 (2176)	8.4 (1695)
Urbanization level		
<10,000 inhabitants	11.2 (623)	8.0 (444)
10-100,000 inhabitants	13.2 (1246)	8.7 (824)
100-500,000 inhabitants	14.8 (973)	10.9 (717)
>500,000 inhabitants	14.2 (1710)	12.1 (1462)
Exposure to passive smoke		
yes	14.8 (2509)	11.1 (1890)
no	12.2 (2019)	9.3 (1540)
Presence of mould stains		
yes	17.4 (631)	13.1 (475)
no	12.9 (3598)	9.7 (2696)
<i>missing</i>	<i>14.8 (323)</i>	<i>12.7 (276)</i>
Parental education		
primary school	15.1 (207)	11.9 (163)
secondary school	14.2 (1420)	11.2 (1113)
high school	13.3 (2031)	9.7 (1480)
university	12.7 (853)	9.8 (658)

Table 3. Associations between traffic indicators and current asthma symptoms and persistent cough or phlegm

	Current asthma symptoms				Persistent cough or phlegm			
	n cases	(%)	OR*	95% CI	n cases	(%)	OR*	95% CI
Traffic density								
absent	589	12.6	1.00		421	9.0	1.00	
low	1278	12.7	1.02	0.91-1.14	882	8.8	0.96	0.85-1.09
moderate	1417	13.8	1.09	0.98-1.22	1070	10.5	1.07	0.94-1.22
high	818	14.7	1.14	1.00-1.29	696	12.5	1.22	1.06-1.41
Frequency cars transit								
never	319	12.8	1.00		214	8.6	1.00	
sometimes	1198	12.3	0.96	0.84-1.10	812	8.3	0.95	0.81-1.12
frequently	1443	13.6	1.05	0.92-1.20	1064	10.1	1.09	0.92-1.30
continuously	1143	14.9	1.13	0.98-1.30	983	12.8	1.36	1.15-1.61
Frequency trucks transit								
never	1460	12.4	1.00		1015	8.6	1.00	
sometimes	1703	13.7	1.10	1.01-1.18	1245	10.0	1.12	1.03-1.22
frequently	706	14.5	1.15	1.04-1.27	591	12.1	1.33	1.19-1.49
continuously	220	15.8	1.26	1.08-1.48	218	15.7	1.82	1.54-2.16

* All ORs were adjusted for study centre, age, sex, parental asthma or atopy, parental education, passive smoke at home and indoor moulds

Table 4. Associations between traffic indicators and current asthma symptoms with or without persistent cough or phlegm.

	Current asthma symptoms WITHOUT persistent cough or phlegm				Persistent cough or phlegm WITHOUT current asthma symptoms				Current asthma symptoms WITH persistent cough or phlegm			
	n cases	(%)	OR*	95% CI	n cases	(%)	OR*	95% CI	n cases	(%)	OR*	95% CI
Traffic density												
absent	436	9.3	1.00		268	5.7	1.00		153	3.3	1.00	
low	922	9.2	0.98	0.87-1.11	526	5.2	0.90	0.78-1.04	356	3.5	1.10	0.91-1.34
moderate	982	9.6	1.04	0.91-1.18	635	6.2	0.98	0.85-1.14	435	4.3	1.24	1.03-1.49
high	540	9.7	1.07	0.93-1.23	418	7.5	1.16	0.98-1.37	278	5.0	1.43	1.15-1.77
Frequency cars transit												
never	240	9.6	1.00		135	5.4	1.00		79	3.2	1.00	
sometimes	870	8.9	0.92	0.79-1.07	484	5.0	0.92	0.76-1.11	328	3.4	1.00	0.78-1.28
frequently	1029	9.7	1.01	0.87-1.17	650	6.1	1.11	0.91-1.35	414	3.9	1.11	0.88-1.42
continuously	739	9.6	1.03	0.88-1.20	579	7.5	1.33	1.10-1.62	404	5.3	1.44	1.13-1.85
Frequency trucks transit												
never	1081	9.2	1.00		636	5.4	1.00		379	3.2	1.00	
sometimes	1182	9.5	1.05	0.96-1.15	724	5.8	1.06	0.95-1.18	521	4.2	1.28	1.12-1.46
frequently	474	9.7	1.08	0.96-1.22	359	7.4	1.32	1.17-1.50	232	4.8	1.47	1.23-1.75
continuously	133	9.6	1.19	0.98-1.43	131	9.4	1.72	1.41-2.10	87	6.3	2.03	1.59-2.58

* All ORs were adjusted for study centre, age, sex, parental asthma or atopy, parental education, passive smoke at home and indoor moulds

Table 5. Associations between combined exposure to truck and car transit and persistent cough or phlegm.

		Trucks transit			
		Never	Sometimes	Freq/continuously	
Cars transit	Never/ sometimes	<i>n cases (%)</i>	656 (7.9%)	335 (9.1%)	28 (11.4%)
		OR* (95% CI)	1.00	1.15 (1.01-1.31)	1.39 (0.93-2.08)
	Frequently	<i>n cases (%)</i>	272 (9.9%)	570 (9.6%)	220 (11.8%)
		OR* (95% CI)	1.19 (1.02-1.38)	1.13 (1.00-1.28)	1.45 (1.22-1.73)
	Continuously	<i>n cases (%)</i>	85 (11.5%)	336 (12.0%)	561 (13.6%)
		OR* (95% CI)	1.34 (1.01-1.77)	1.39 (1.20-1.61)	1.59 (1.39-1.82)

* All ORs were adjusted for presence of current asthma symptoms, study center, age, sex, parental asthma or atopy, parental education, passive smoke at home and indoor moulds.

Figure 1

